Energy and Mobility

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The fastest growing demand for energy comes from vehicle traffic. In Europe about 50% of the population own a private car, the world average is 12%, China and India are below 5%. 

![Graph showing the relationship between Bruttoinlandsprodukt (BIP) pro Kopf und Jahr in 1000 US$ and PKW pro 100 Einwohner. The graph illustrates a correlation between economic wealth and car ownership. Countries are plotted on the graph, with a trend line indicating the general trend.]
Energy and Mobility

- Porsche 911
- Mercedes E
- VW Golf

Engine power / HP

- 170 PS
- 130 PS
- 44 PS
- 270 PS
- 525 PS
- 530 PS
Energy consumption per Head

Quelle: World Energy Council 2006
Green house gases like CO$_2$, CH$_4$, N$_2$O produced by combustion of fossil fuels, by agriculture and cattle breeding cause the global temperatures to rise giving way to extreme climatic situations and threatening flora and fauna.
At present 81% of our primary energy demand are covered from fossil sources. Fossil sources are limited and their use causes dangers to the environment by the emission of CO₂ and accidents.

**Global primary energy consumption 2006: 490 Exajoule**

- **Fossils**
  - oil: 34%
  - coal: 26%
  - gas: 21%
- **Renewables**: 13%
- **Nuclear**: 6%

Global Warming

Source: ICPP 2007
CO$_2$-Emissionen Food

- the production of 1 kg meat needs 7-16 kg grains
- the production of 1 kJ meat needs around 9 kJ grains
- a cow causes the same greenhouse gas emissions due to methane as a car that drives 18,000 km a year
Future I
Future II
Future III
Hydrogen is the most abundant element in the universe, more than 90% of all atoms are hydrogen. Hydrogen is the main component and main energy source of stars. Hydrogen is the simplest atom, consisting of one proton and one electron only. Due to its one valence electron, hydrogen is very reactive and combines to the molecule H2 at ambient conditions.

At normal temperature and pressure, hydrogen is a colourless, odourless gas with no toxic effects. It is the lowest density element and therefore requires a large storage volume, whilst also having a high diffusion coefficient. After Helium, element No. 1 has the lowest melting and boiling points.

On earth hydrogen is rarely found in pure form, but usually in a wide variety of inorganic and organic chemical compounds, the most common being H2O water. Hydrogen forms chemical compounds with nearly all other elements, so called hydrides.
Inorganic hydrides (e. g. H₂O, NH₃) and organic hydrides like hydrocarbons (e. g. methane CH₄, ethane C₂H₆, benzene C₆H₆), alcohols (e. g. methanol CH₃OH, ethanol C₂H₅OH), acids, fats, carbohydrates (e. g. glukose C₆H₁₂O₆) und proteins are essential for life.
Hydrogen provides a **sustainable energy cycle** with closed loop feedstock:
- **Production** from water through electrolysis
- **Storage** as compressed gas, liquified or in compounds
- **Combustion** in fuel cells or internal combustion engines emitting water

Source: Züttel 2008
Production of Hydrogen:
Hydrogen production via electrolysis of water using electricity from alternative sources like water, wind and sun allows a sustainable energy cycle without emissions.
Application of Hydrogen:

Hydrogen is highly inflammable in air and can be combusted in internal combustion engines, fuel cells and turbines.
1783 used as gas for filling a balloon

1839 William Grove invented the fuel cell
1807 Francois de Rivaz built the first vehicle with a simple internal combustion engine using hydrogen as fuel.
1860 Etienne Lenoir built the first commercially available internal combustion engine using hydrogen as fuel. He mounted his engine in a vehicle called Hippomobile.
Early fuel cell vehicles were presented and used by General Motors 1966 and by Austrian Karl Kordesch 1970.
First Austrian research center for hydrogen with testing and dispensing facilities for LH2 and CGH2, opened 2005
• Testing activities with specific test setups with electronic process control with LH2 and GH2

• Thermodynamic analysis of processes and systems

• Scientific research and lecturing

• Security and standards

• Publications and congresses
Project HYCAR 1: First Austrian multi-flex-fuel vehicle for operation with gasoline, natural gas, hydrogen, and mixtures thereof
SAE 2009-01-1420, IJVD 45 2 2010
BMW i3 electric car / 125 kW el / 2013
BMW i8 hybrid electric car / 130 kWel + 120 kWdiesel / 2014
Honda FCEV Concept, 2013 Los Angeles Auto Show
Toyota FCV concept, 2013 Tokyo Motor Show