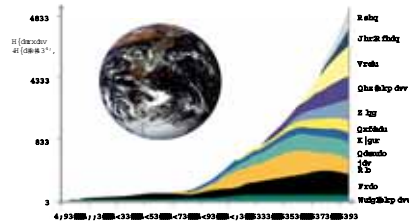
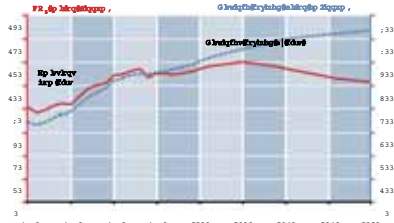




# BMW Energy Strategy. Short-Term and Long-Term Solutions.

**Motivation:** Reduction of greenhouse gas emissions, preserve the finite fossil fuels, secure energy supply



**Short- and mid-term Targets:**  
Reduction of fuel consumption



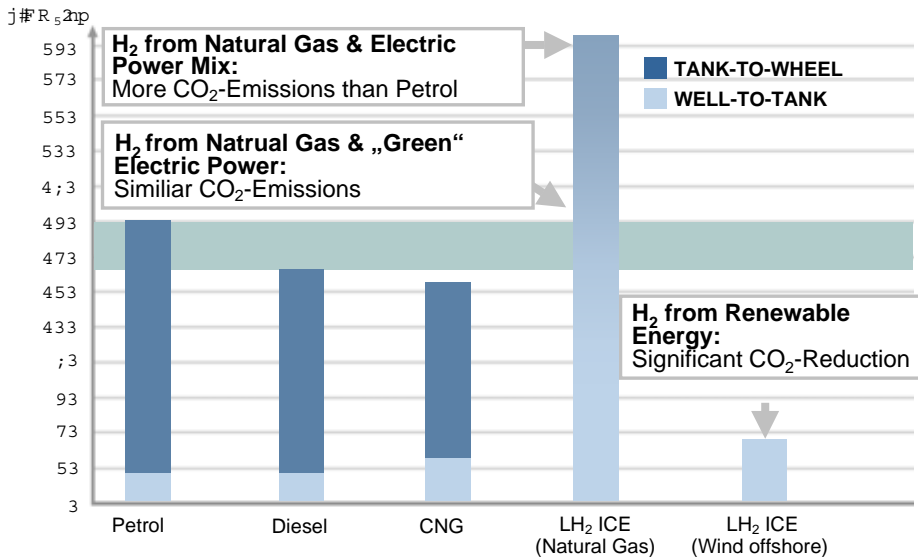
Gasoline: e.g. VALVETRONIC  
Diesel: e.g. Common-Rail 2. Generation



**Long-term Targets :**  
Development of competitive and sustainable products:  
e.g. Hydrogen Vehicles

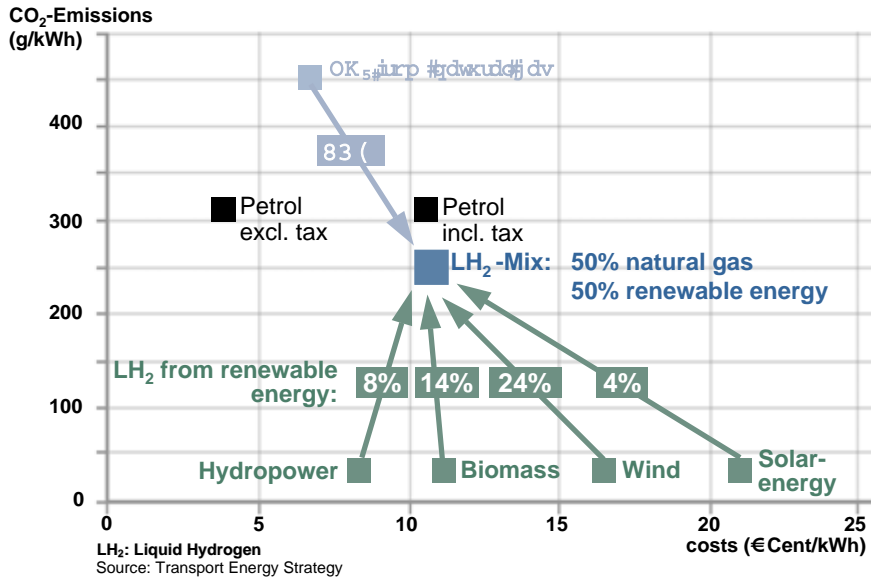


# Well-to-Wheel Comparison of Fuels. CO<sub>2</sub>-Emissions of ICE's.



Source: Transport Energy Strategy

## Liquid Hydrogen LH<sub>2</sub>: Costs and CO<sub>2</sub> Emissions. Comparison of Production Options.



## Agenda.

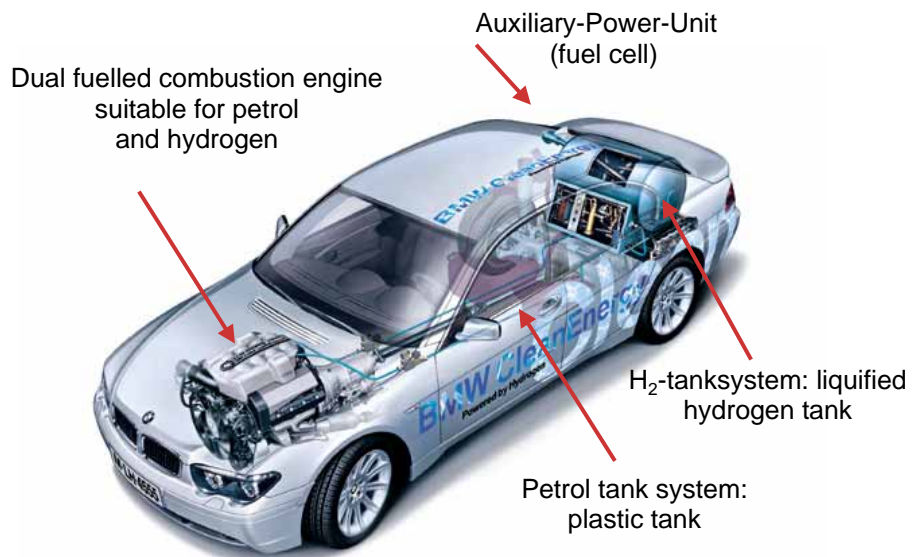
- 1 Motivation: **The Way From Carbon to Hydrogen.**
- 2 H<sub>2</sub> Fuelled Cars: **On the Way to Serial Production.**
- 3 Initiatives, Challenges: **Demonstration Projects are Needed.**

## CleanEnergy. 6 Generations of BMW Hydrogen Vehicles.

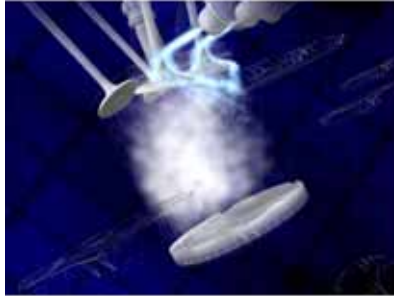


> 100.000 miles driven in hydrogen operation mode in 2001/2002

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## BMW CleanEnergy. Research Activities.

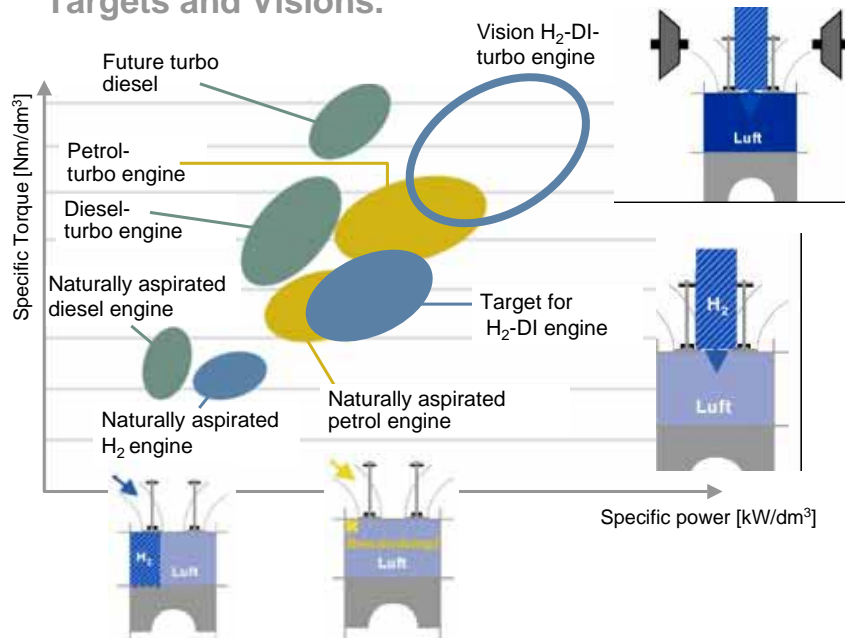


Cryogenic carburation  
(~ -200 °C)



High-pressure DI  
(~ 200 bar)

## Hydrogen Powertrain. Targets and Visions.



## Auxiliary Power Unit (APU). Integrated H<sub>2</sub>Fuel Cell as APU.



„Unlimited“ supply of electricity  
independent of engine operation

- **New comfort feature:**  
Air conditioning during standstill
- **Efficient energy supply:**  
Protection of rising energy demand
- **Further system advantages:**  
Discharge of engine through auxiliary aggregates  
Utilisation of H<sub>2</sub> Boil-Offs

## Different Hydrogen Propulsion Systems. Common Infrastructure Requirements.

### Internal Combustion Engine ICE:

- + Power/weight & power/volume ratio
- + Cost-efficient production
- + Proven durability



Both drive train concepts include specific advantages and further development potential. The entry into a “hydrogen world” requires both: setting up activities of the petroleum industry and extensive choice of automobiles

### Fuel Cell & E-Motor:

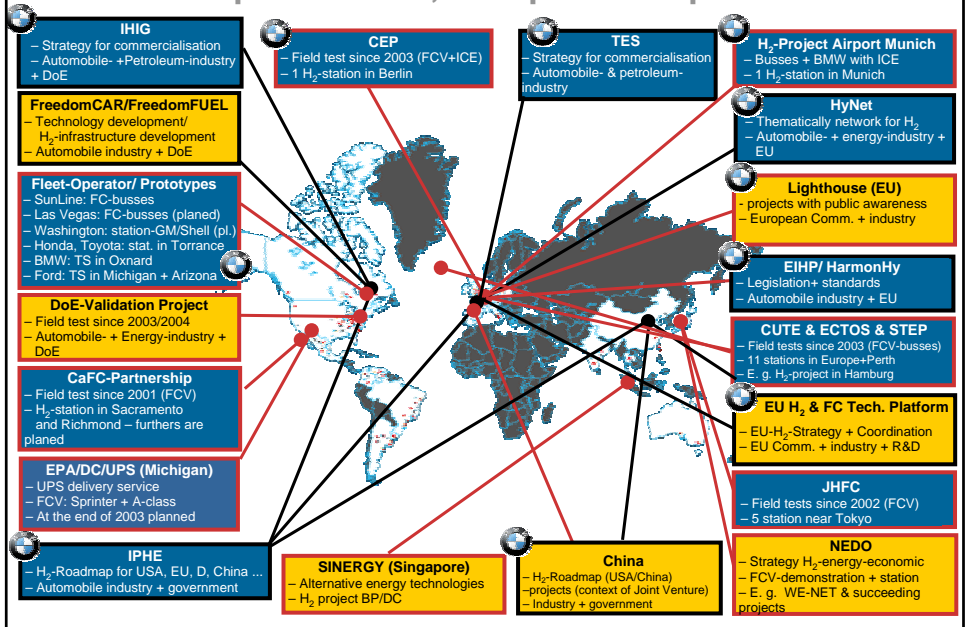
- + High starting torque
- + Zero Emission Vehicle
- + Wide-spread public acceptance for urban traffic?



# Agenda.

- 1 Motivation: **The Way From Carbon to Hydrogen.**
- 2 H<sub>2</sub> Fuelled Cars: **On the Way to Serial Production.**
- 3 Initiatives, Challenges: **Demonstration Projects are Needed.**

# Hydrogen Activities Worldwide. Hot Spots in USA, Europe and Japan.



## Hydrogen Activity. From the Wish to the Reality.

### Hydrogen-vehicle-technology

*Development in direction to series capability!*

- Improvement of efficiency (ICE and fuel cell)
- International standards (H<sub>2</sub>-storage, tank coupling, security, ...)



### Hydrogen generation

*Higher h, lower investment-costs!*

- Improvement of efficiency (electrolysis, liquefaction)
- Integration reliable components in the H<sub>2</sub>-generation chain
- Strategy for a H<sub>2</sub>-primary energy mix („co sts versus emissions“)

### Hydrogen infrastructure

*Only together with petroleum economy!*

- International consensus: H<sub>2</sub> as as future fuel
- Concept for financing the set up of the basic H<sub>2</sub>-infrastructure
- Clear political general framework

## CleanEnergy Cycle.

