

# DAIMLERCHRYSLER

The 22nd International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium

## **Well-to-Wheel Visualization**

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  - [www.optiresource.org](http://www.optiresource.org) for further information
- Optiresource Foundation

## Motivation of an OEM for alternative drivetrains

- Individual mobility and efficient transport are an important basis of modern society and economy
- An affordable, reliable and environmentally benign long term fuel supply is a prerequisite for unrestricted mobility

### Driving Forces

- Effective global reduction of CO<sub>2</sub> Emissions
- Securing of Energy Supply by Reducing the Dependence on Oil Imports from Politically Unstable Regions
- Reduction of the Consumption of Fossil Fuels, and
- Need for Cleaner Fuels to Support Emission Reductions

# Elements of a hydrogen supply infrastructure

## Primary Energy

- Crude Oil
- Natural gas
- Coal
- Uranium
  
- Solar
- Wind
- Hydro
- Geothermal
- Biomass
- Waste

## Production

- Reforming
- Gasification
- Electrolysis
- HT-Splitting
- Thermo-Solar
- Solar direct
  
- Central
- On site

## Distribution

### Conditioning

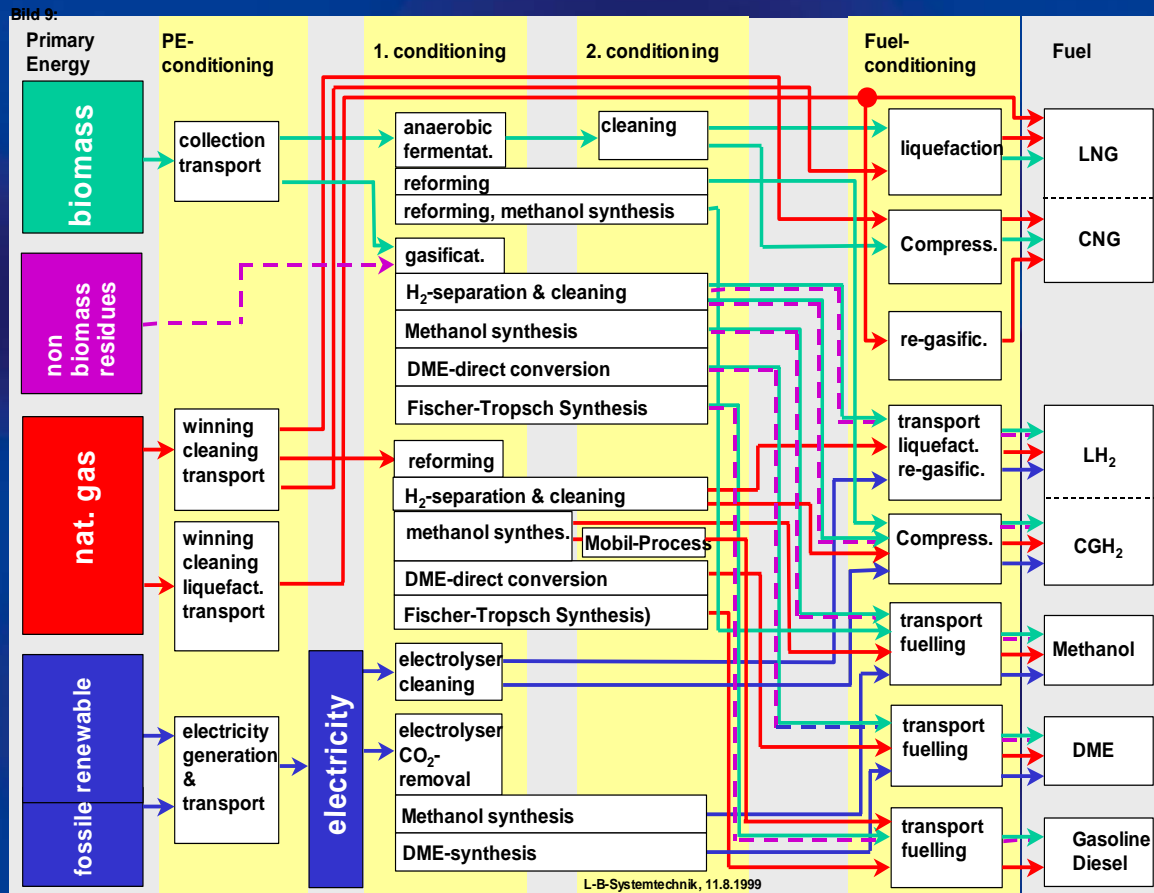
- Compression
- Liquification
- Synthesis

### Transport

- Pipeline
- Truck
- Ship



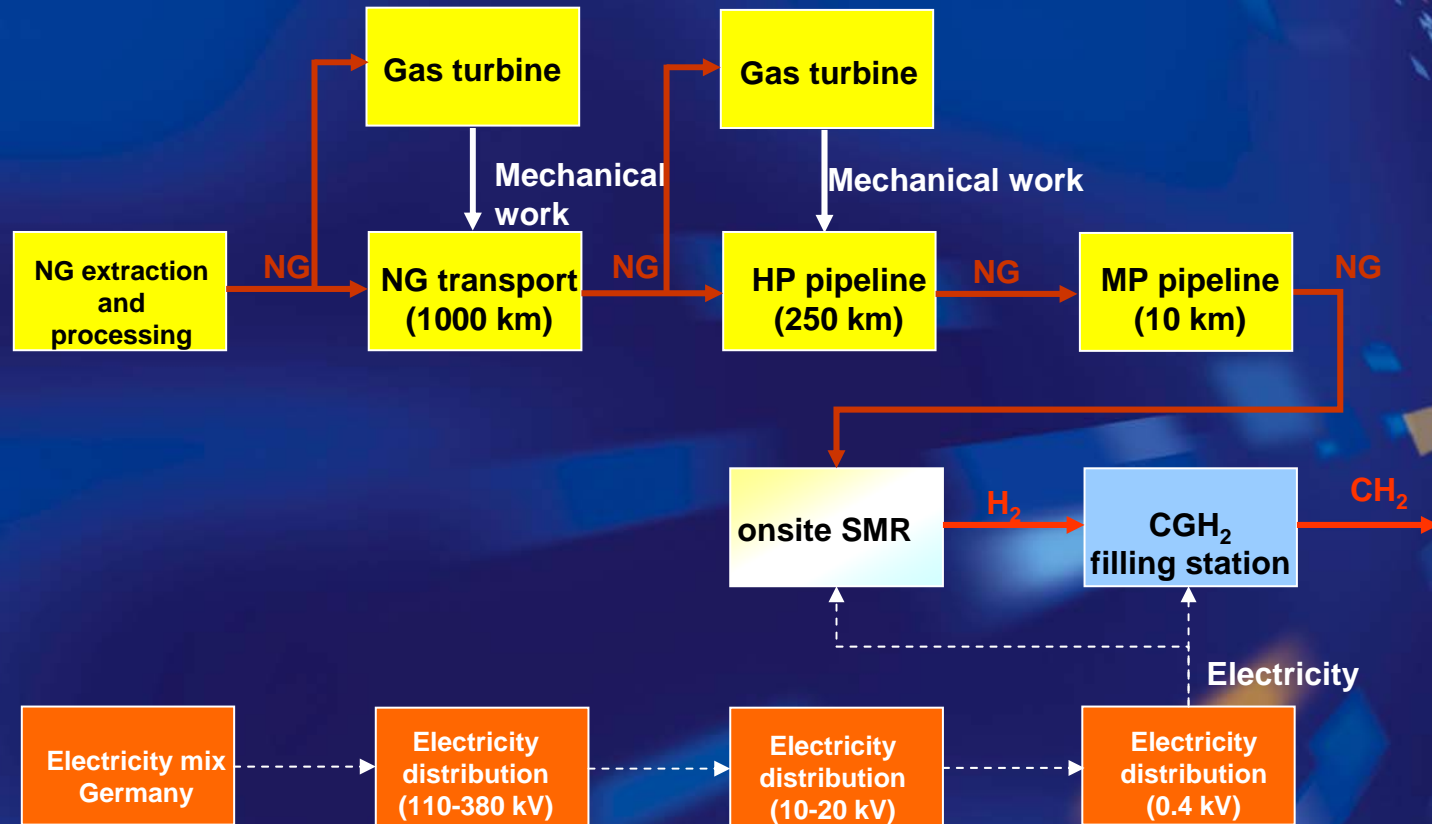
# Well-to-Wheel parameters and data origin



Basic WtW data (for EU) have been researched by CONCAVE/EUCAR/JRC and are widely accepted,

...but high complexity affords detailed knowledge of correlations and processes as well as powerful calculation methods (e.g. E3-database from LBST).

# Example for a H<sub>2</sub>-supply chain: CH<sub>2</sub> from on site reforming of natural gas



# Present WtW studies

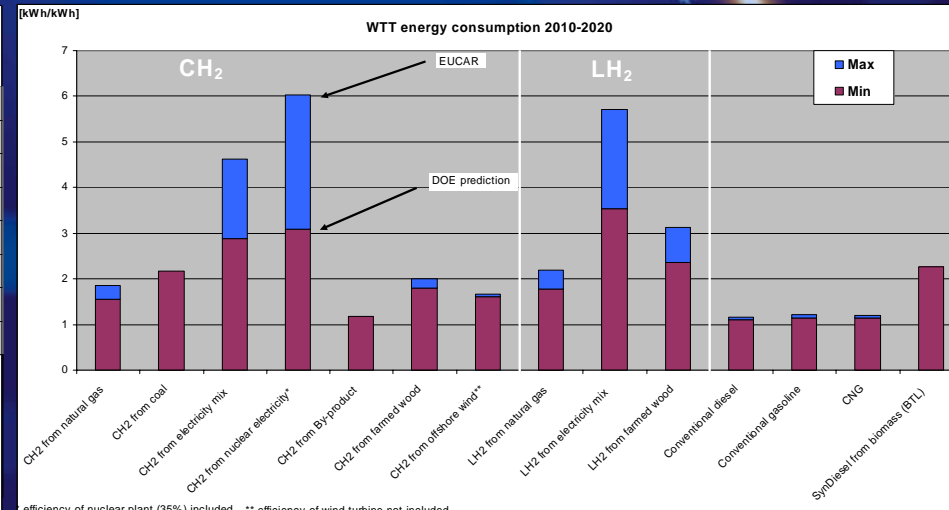
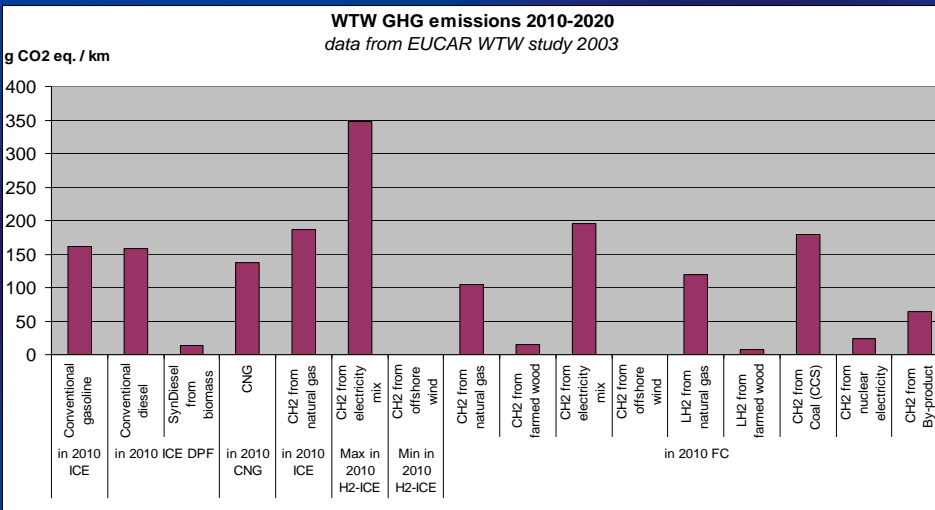


<http://www.transportation.anl.gov>  
**GM WtW North America**

<http://www.lbst.de/gm-wtw>  
**GM WtW Europe**

<http://ies.jrc.ec.eu.int>  
**CONCAWE/EUCAR/JRC**

# Sample of actual WtW data visualization

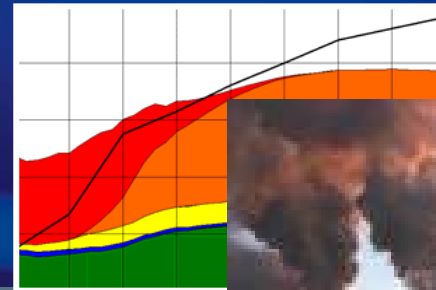


Premises are difficult to show, data are difficult to compare, add and sort.  
No interactivity and difficult replication.



## Criteria to define a vehicle development strategy

- Energy Consumption
- CO2 emissions
- Fossil fuel consumption



### First 3 criteria to be considered in Optiresource

- Investment, cost
- Marketshare, market
- Performances
- PM, NOx, HC emissions
- Grey energy
- Recycling
- ...

## Basic specifications of OPTIRESOURCE software

- Interactive and easy-to-use SW to get quick and clear answers to many questions:
  - how do different energy chains compare in terms of energy consumption, GHG emissions etc.?
  - what are the chains allowing for the optimization of the consumptions and emissions?
  - what is the impact of different energy scenarios?
  - and many others.....
- Interactive software & database are stored in a USB key
- SW only needs Windows 2000/XP with MS “.net Framework”
- SW is designed as a modular and scalable system. The same data-base has different “modes” and different user interfaces
- In the current version 2 “modes” and 3 user interfaces are implemented

## Implementation of OPTIRESOURCE software

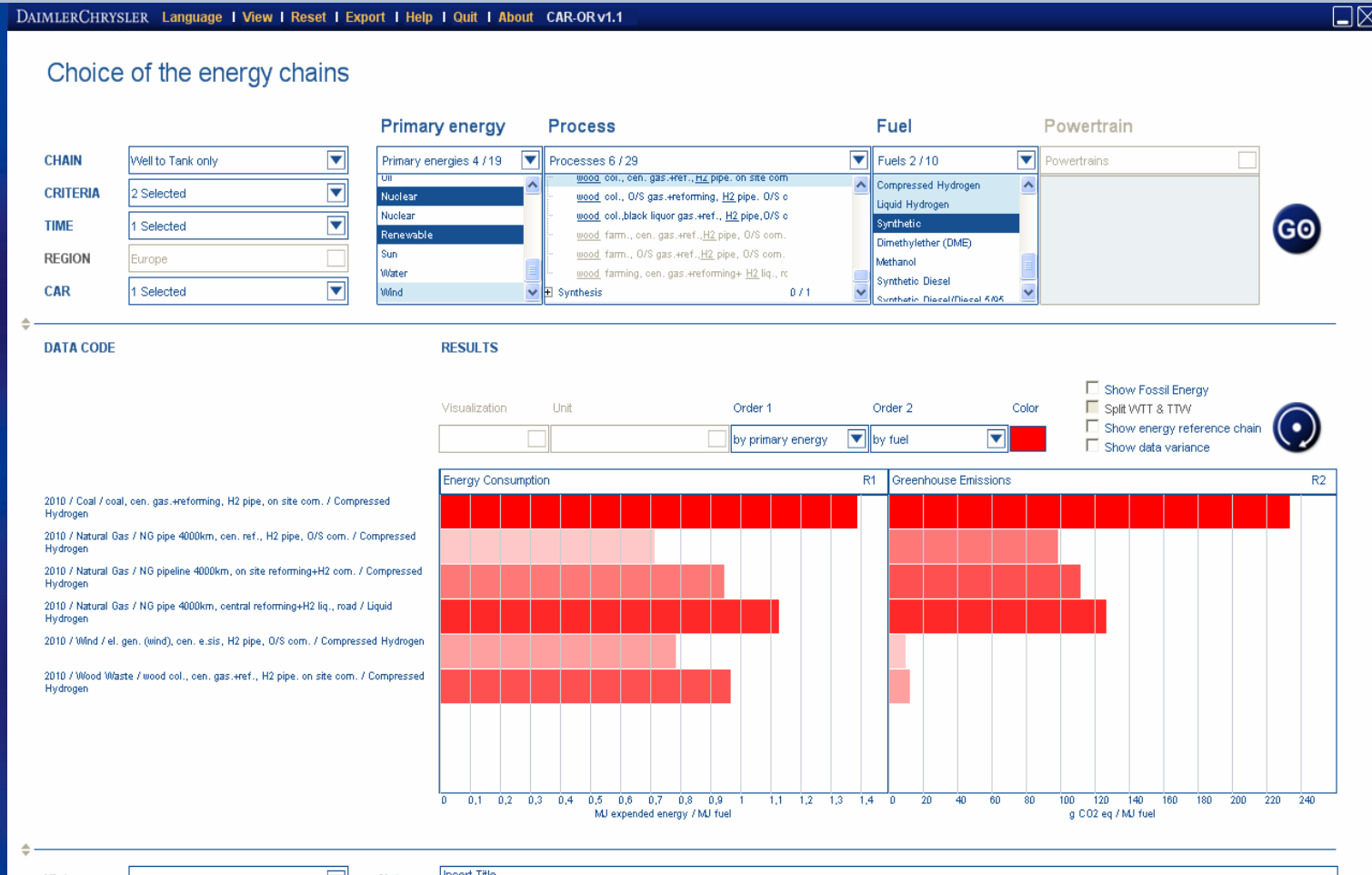
### ■ “Modes”

- “Query mode”: the user selects the chains according certain criteria and then the results are visualized (more than 500 chains available)
- “Scenario Mode”: the users defines scenarios in terms of energy supply and energy demand and then visualize and compare them (available starting from January 2007)

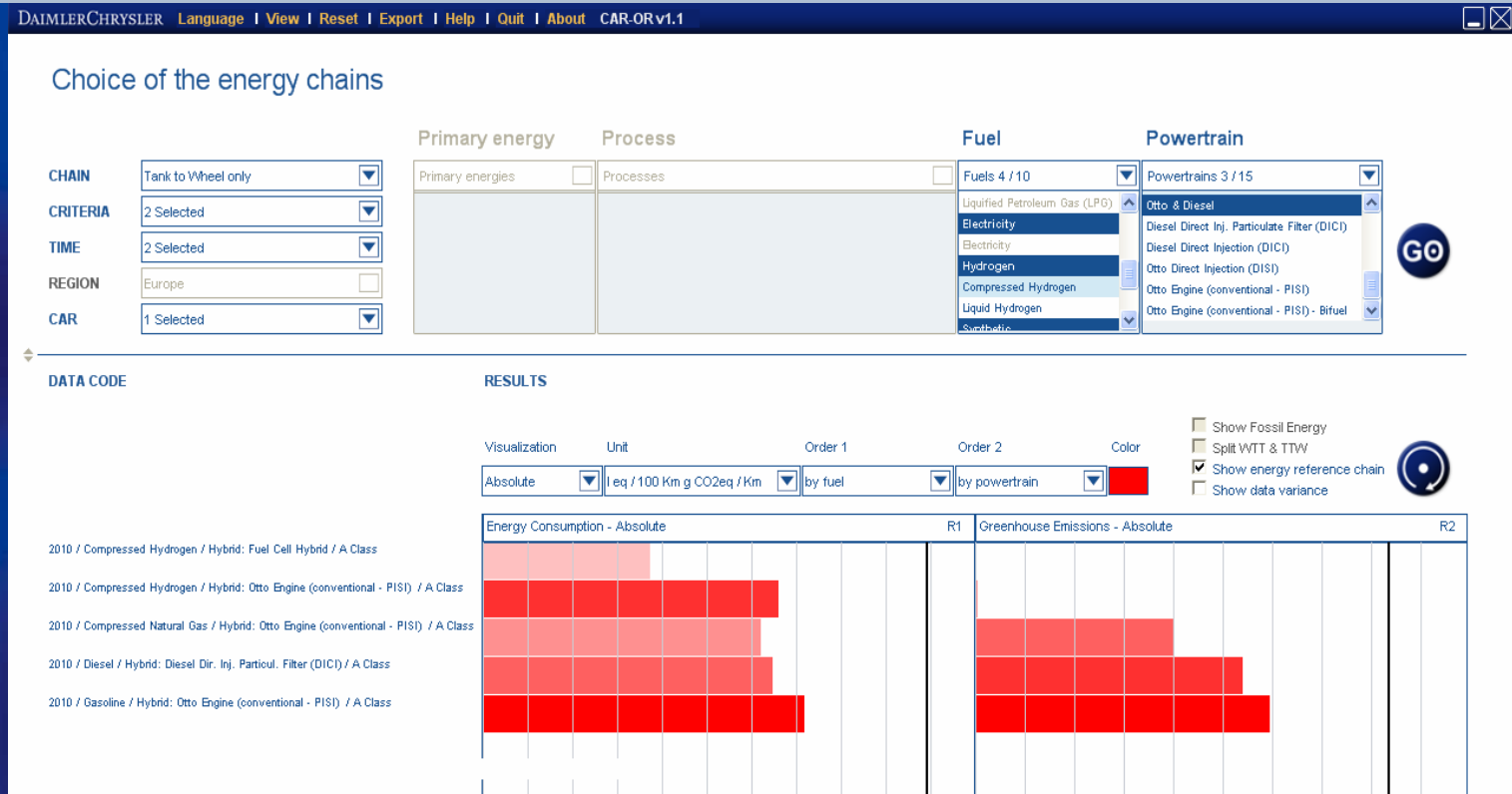
### ■ User interfaces

- User interfaces:
  - “For Experts”
  - “For All Users”
  - “For Exhibitions”

# Example for WtT results: Energy consumption and GHG-emissions for H<sub>2</sub>- production from various primary energy sources



# Example for TtW results: Energy consumption and GHG emissions of various drivetrains



# Example for WtW results: Vehicle drive train: Fuel cell hybrid Fuel: Hydrogen from different primary energies

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## Choice of the energy chains

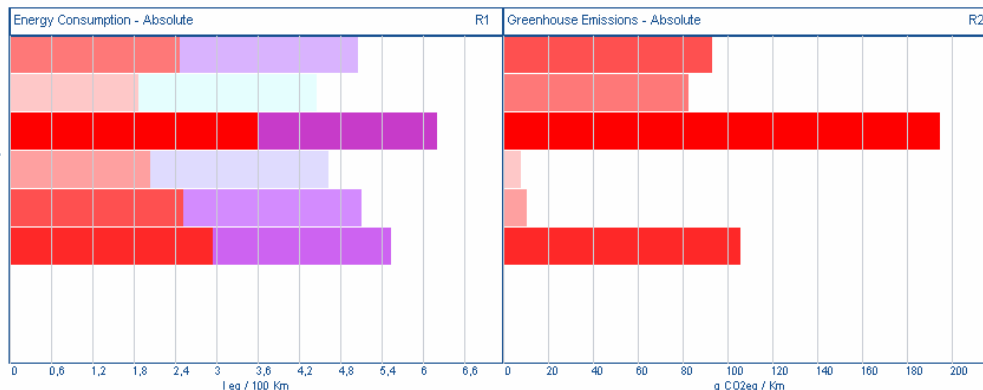
<b>CHAIN</b>	Complete: Well to Wheel	<b>Primary energy</b>	Primary energies 4 / 19	<b>Process</b>	Processes 6 / 29	<b>Fuel</b>	Fuels 2 / 10	<b>Powertrain</b>	Powertrains 1 / 4
<b>CRITERIA</b>	2 Selected		Nuclear	wood_cool., cen. gas.-ref., H2 pipe, on site com		Compressed Hydrogen		Electric	
<b>TIME</b>	1 Selected		Nuclear	wood_cool., O/S gas.-ref., H2 pipe, O/S c		Liquid Hydrogen		Electric Vehicle with Li-Ion Battery	
<b>REGION</b>	Europe		Renewable	wood_cool., black liquor gas.-ref., H2 pipe, O/S c		Synthetic		Electric Vehicle with Na-NiCl Battery	
<b>CAR</b>	1 Selected		Sun	wood_farm., cen. gas.-ref., H2 pipe, O/S com.		Dimethylether (DME)		Electric Vehicle with Ni-MH Battery	
			Water	wood_farm., O/S gas.-ref., H2 pipe, O/S com.		Methanol		Fuel Cell	
			Wind	wood_farming, cen. gas.-ref., H2 liq., rc		Synthetic Diesel		Hybrid: Fuel Cell Hybrid	
				Synthesis	0 / 1	Synthetic Diesel/Diesel F505			



### DATA CODE

### RESULTS

Visualization: Absolute | Unit: l eq / 100 Km g CO2eq / Km | Order 1: by fuel | Order 2: by powertrain | WTT:  | TTW:  |  Show Fossil Energy |  Split WTT & TTW |  Show energy reference chain |  Show data variance



# Example for WtW results: Vehicle drive trains: Fuel cell and ICE Fuels: Compressed hydrogen, gasoline and compressed natural gas

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## Choice of the energy chains

<b>CHAIN</b>	Complete: Well to Wheel	<b>Primary energy</b>	Primary energies 4 / 19	<b>Process</b>	Processes 6 / 27	<b>Fuel</b>	Fuels 4 / 7	<b>Powertrain</b>	Powertrains 3 / 15
<b>CRITERIA</b>	2 Selected		Oil		wood col., cen. gas.-ref., H <sub>2</sub> pipe, on site com.		Liquid Petroleum Gas (LPG)		Hybrid: Otto Engine (conventional - PIS)
<b>TIME</b>	1 Selected		Nuclear		wood col., O/S gas.-reforming, H <sub>2</sub> pipe, O/S com.		Electricity		Otto & Diesel
<b>REGION</b>	Europe		Nuclear		wood col., black liquor gas.-ref., H <sub>2</sub> pipe, O/S com.		Electricity		Diesel Direct Inj. Particulate Filter (DIC)
<b>CAR</b>	1 Selected		Renewable		wood farm., cen. gas.-ref., H <sub>2</sub> pipe, O/S com.		Hydrogen		Diesel Direct Inj. Particulate Filter (DIC)
			Sun		wood farm., O/S gas.-ref., H <sub>2</sub> pipe, O/S com.		Compressed Hydrogen		Otto Direct Injection (DIS)
			Water		wood farming, cen. gas.-reforming+ H <sub>2</sub> liq., road		Liquid Hydrogen		Otto Engine (conventional - PIS)
			Wind		Synthesis	0 / 1	Synthetic		



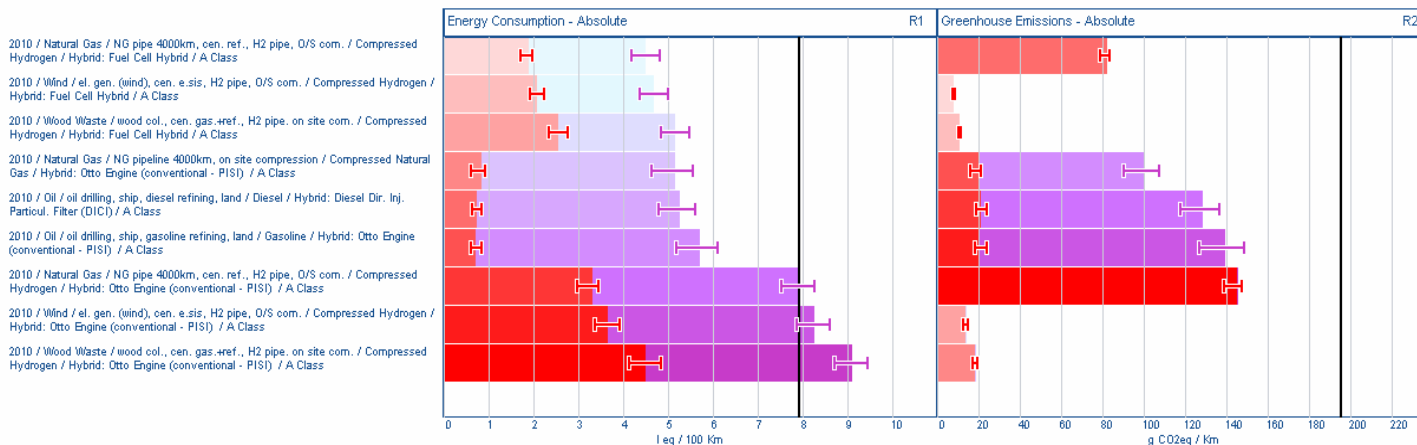
### DATA CODE

### RESULTS

Visualization Unit Order 1 Order 2 WTT TTW

Absolute l eq / 100 Km g CO<sub>2</sub>eq / Km by energy asc. by fuel

Show Fossil Energy  
 Split WTT & TTW  
 Show energy reference chain  
 Show data variance



# Example of QUERY-MODE visualization „for All Users“





## Outlook

Now....try out yourself - on the EVS-22 DaimlerChrysler stand

### Join the Optiresource Foundation:

- In order to involve more stakeholders, DaimlerChrysler intends to create a Foundation, open to other companies: you can join!
- Joining the Foundation, you participate in the definition of the specifications for the further development of the software.
- Buy & use (starting 2007, January) Optiresource software for optimizing your vehicle/fuel development strategy.
- Suggest further aspects to be included in the software.

....check out [www.optiresource.org](http://www.optiresource.org)



**Thank you very much  
for your attention!**

**ご清聴どうも  
ありがとうございました。**

**Just what the environment needs from a car. Water.**

If nature had one wish, what do you think it would be? A car that doesn't produce exhaust? We thought so too. That's why our hydrogen powered Fuel Cell vehicles only emit water. In fact, as they've proven in recent road tests, they may well be the alternative drive systems of the future. At DaimlerChrysler Research we're developing these intelligent technologies today, for the automobiles of tomorrow.

To find out more about 'Energy for the Future' visit [www.daimlerchrysler.com](http://www.daimlerchrysler.com).