DAIMLER

Comparison of Energy Consumption and Green-House-Gas emissions of different mobility scenarios with Optiresource®

The “Well-to-Wheel” Optimizer used at Daimler

Dr. J. Wind, P. Froeschle

Electrical Vehicle Symposium 23, Anaheim, December 3, 2007

What are the reasons for the current debate?

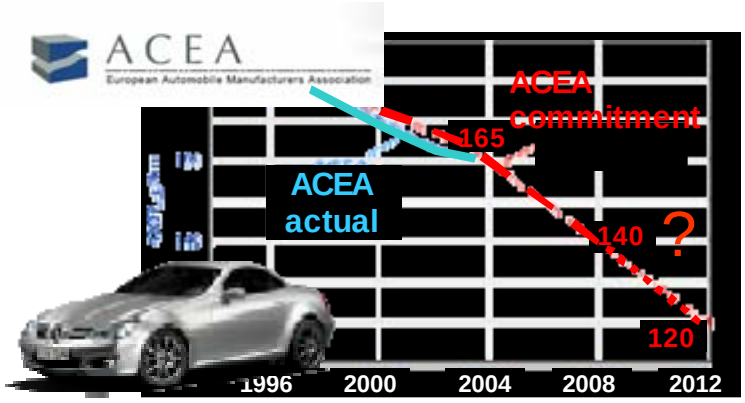
Stern review, Oct. 2006

STERN review
ON THE ECONOMICS OF CLIMATE CHANGE

UNO Climate report, Feb. 2007

Al Gore: *An inconvenient truth*

Failed ACEA Self Commitment



The recent CO_2 - debate takes on different shapes throughout the world

NAFTA:

Independence of oil imports

EU:

Global warming

Asia:

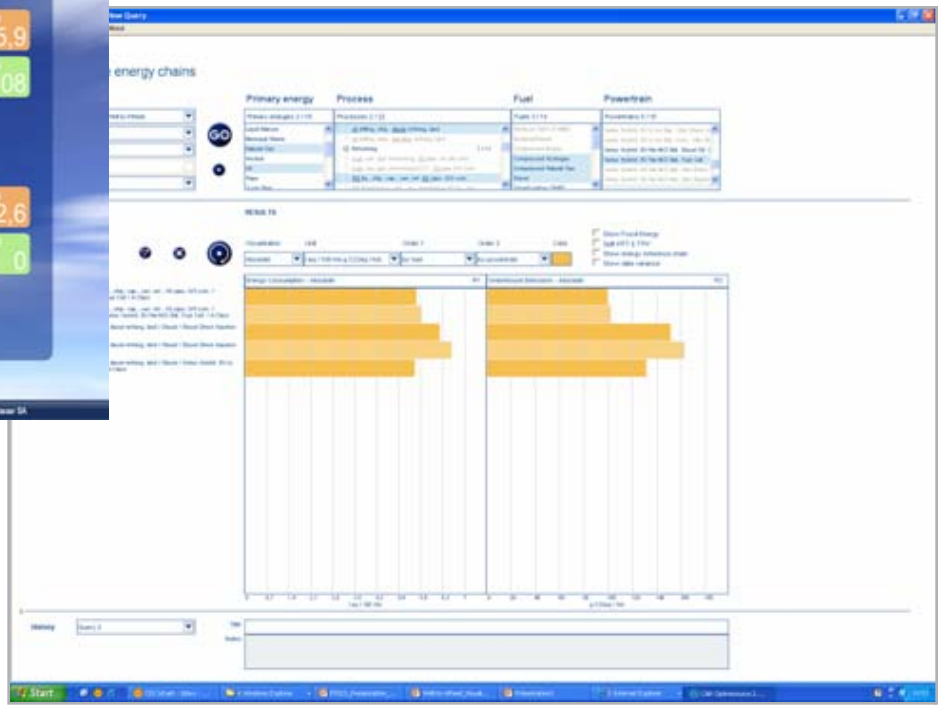
Intensive economic growth

Optiresource is a tool for quick and reliable decisions

Different Optiresource versions for different target groups

Web/Exhibition version

Expert version



The Web version is designed for easy use by non-experts

www.daimler.com/go/optiresource

or

www.optiresource.org

The expert version has a wide variety of funcionalities

The user can

- compare different energy chains in terms of energy consumption, GHG emissions etc.
- detect the chains allowing for the optimization of the consumptions and emissions.
- identify the impact of different energy scenarios.

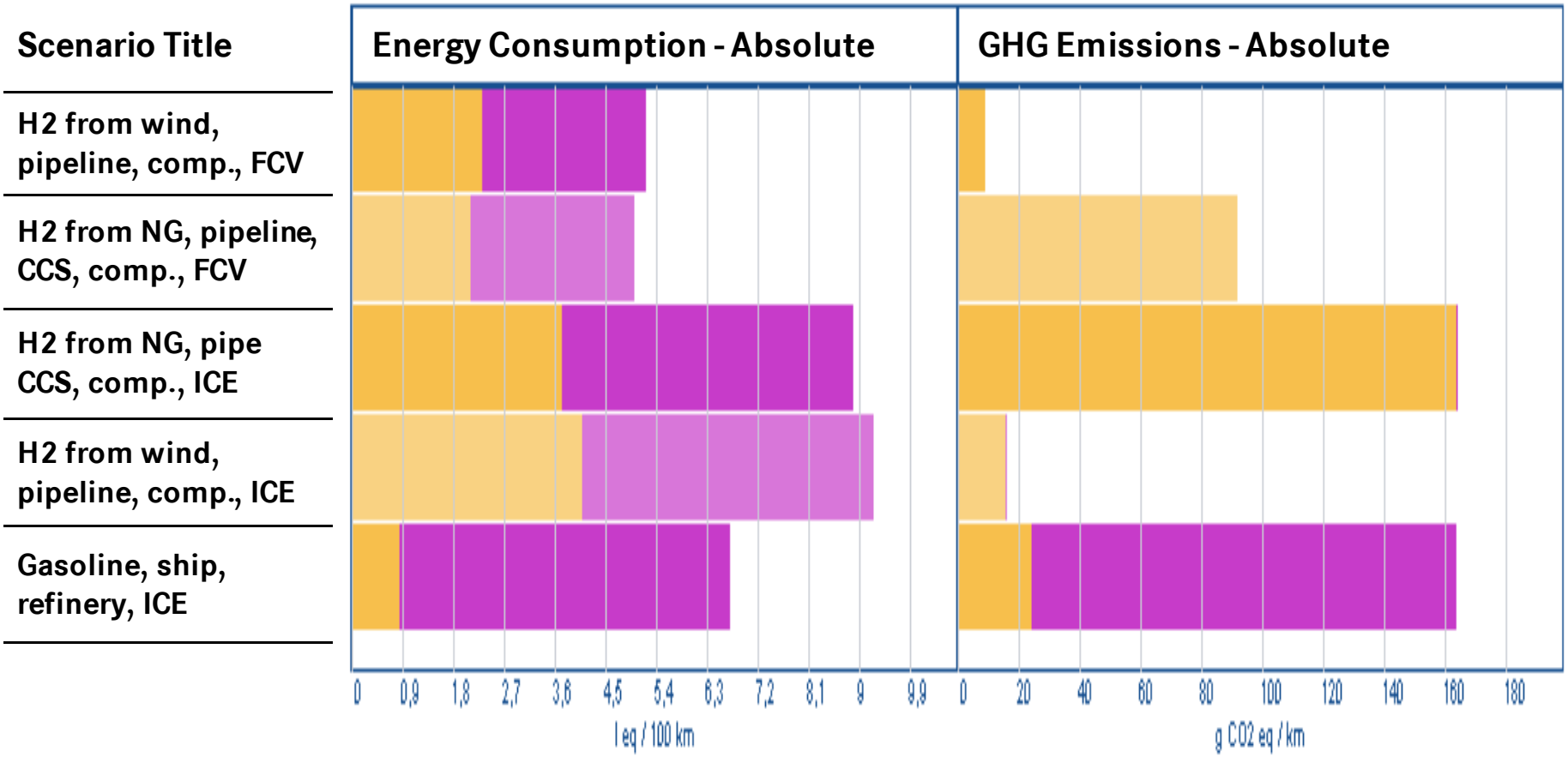
Different modes

- “Query mode”: the user selects the chains according to certain criteria, the results are visualized (almost 1000 chains available)
- “Scenario Mode”: the user defines scenarios in terms of energy supply and energy demand and then visualizes and compares them

Optiresource Query Mode

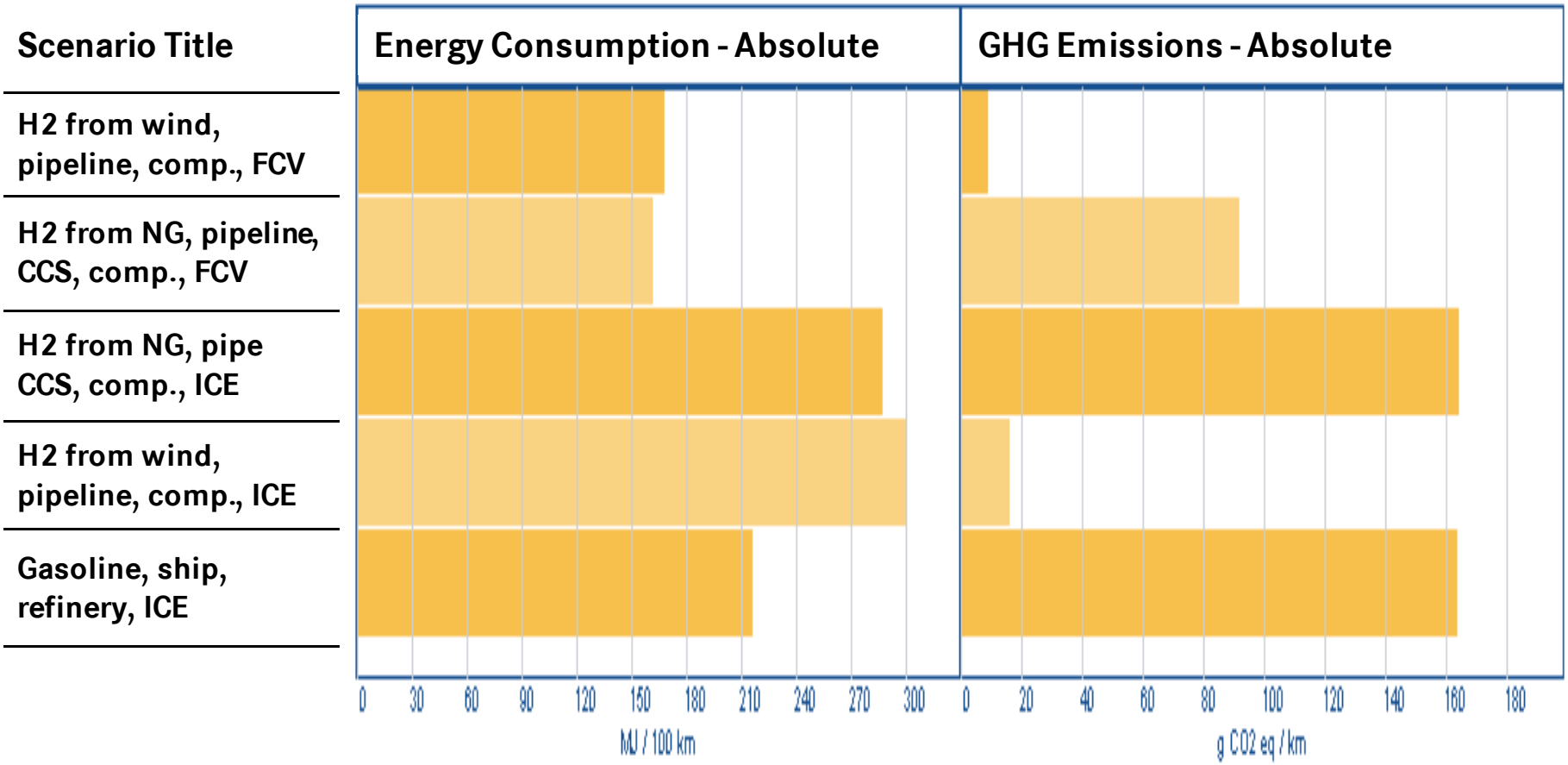
Example for WTW results in the Query Mode

l_{eg}/ 100km



Example for WTW results in the Query Mode

MJ/100km

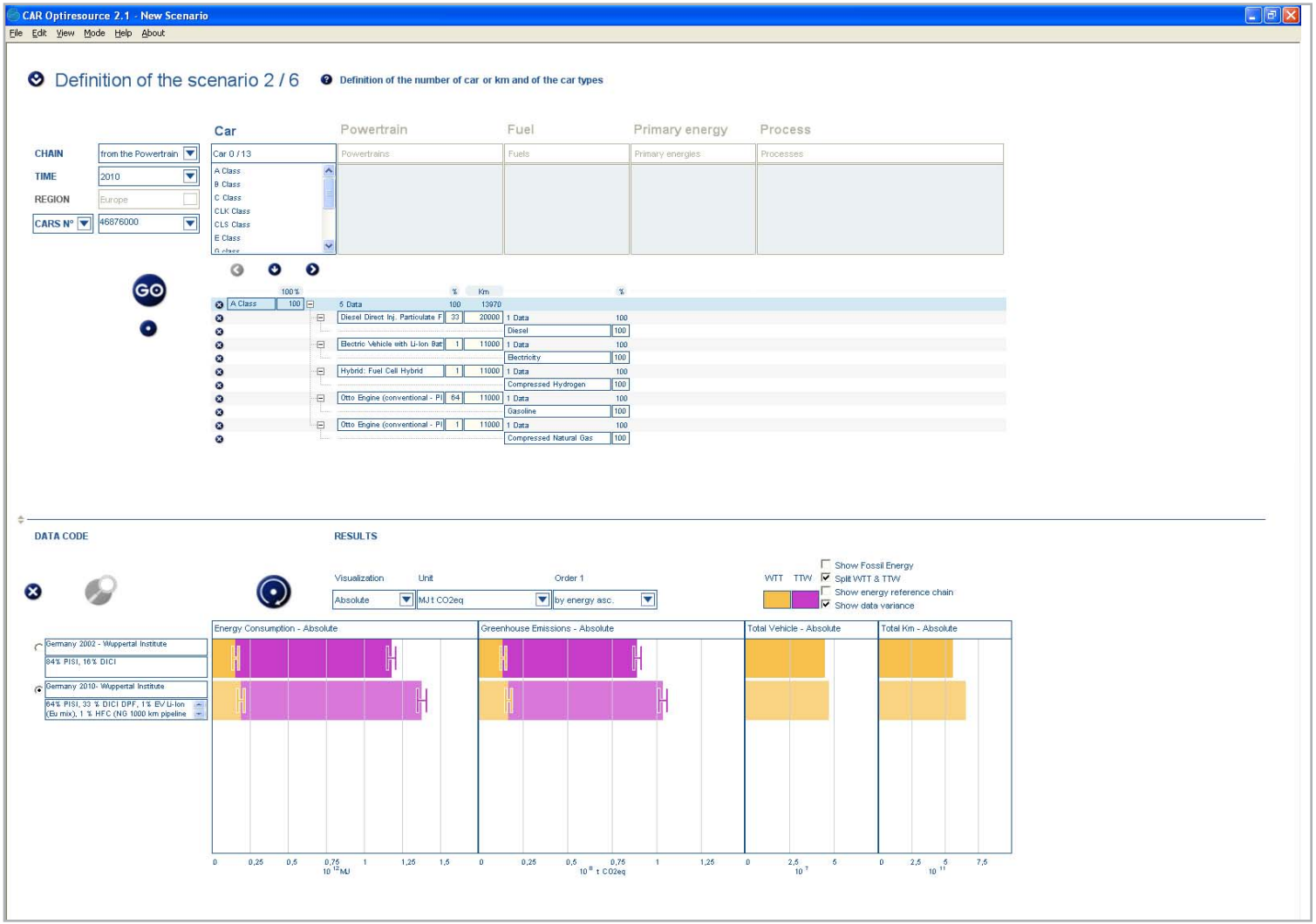


The Optiresource findings for the example query are clearly in favor or renewable hydrogen as a fuel

- By far the lowest GHG emissions and very low energy consumption are achieved by a **Fuel Cell vehicle** powered by H2 from wind energy.
- Hydrogen from NG shows even lower energy consumption but clearly higher GHG emissions than H_2 from wind. However GHG emissions of this pathway are already lower than those from conventional ICEs.
- An **H2 ICE** powered by hydrogen from NG is the worst of all shown both in terms of energy consumption and GHG emissions.

Both in terms of energy consumption and GHG emissions, the **Fuel Cell vehicle** is the best of all alternatives shown

The Scenario mode lets one compare different scenarios in terms of energy consumption and GHG emissions



Very good agreement between Optiresource data and real values

	Total energy consumption for passenger cars tank-to-wheel (TTW) (MJ)	Energy consumption per 100 km TTW (MJ/100km)	Total GHG emissions from passenger cars TTW (tons)	GHG emissions per km TTW (g_{CO2eg}/km)
Data for German passenger cars in 2005	1.48×10^{12}	255	110×10^{6}	189
Results from Optiresource® for simplified scenario for Germany 2005	1.22×10^{12}	210	92×10^{6}	158

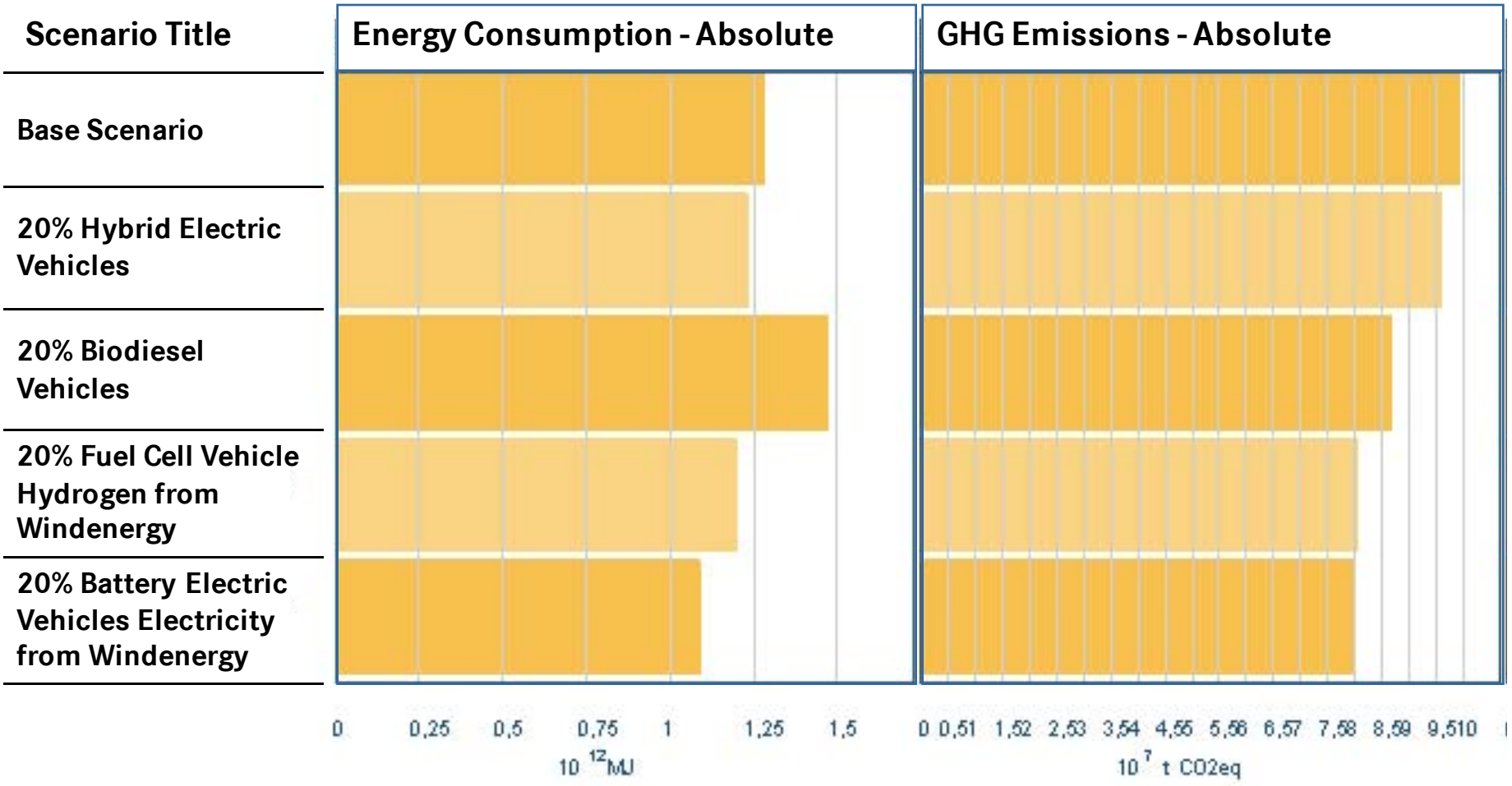
Optiresource figures are slightly lower that real values because

- 2002 compact class reference vehicle was used while actual car fleet is older with higher fuel consumption and GHG emissions.
- Compact class reference vehicle does not represent the variety within car fleet.
- Real driving patterns differ from NEDC.

Definition of example scenarios

Drive Train	Fuel	Szenarios (Share of drive trains)				
		Base scenario	20% Hybrid Electric Vehicles	20% Biodiesel Vehicles	20% Fuel Cell Vehicles, Wind	20% Battery Electric Vehicles, Wind
Otto engine (Port injection)	Gasoline from crude oil	77%	67%	67%	67%	67%
Diesel engine (Direct Injection with particle filter)	Diesel from crude oil	23%	13%	13%	13%	13%
Diesel engine (Direct Injection with particle filter)	Biodiesel from rapeseed	-	-	20%	-	-
Parallel Hybrid with Otto engine	Gasoline from crude oil	-	10%	-	-	-
Parallel hybrid with Diesel engine	Diesel from crude oil	-	10%	-	-	-
Hybridized Fuel Cell Drive Train	Hydrogen from Wind energy (by electrolysis)	-	-	-	20%	-
Li-Ion Battery and Electric Motor	Electricity from Wind energy	-	-	-	-	20%

Comparion of the scenarios in terms of energy consumption and GHG-emissions



The Optiresource analysis of the example scenarios shows FCV to be the only real alternative for the future

- In terms of GHG emissions every alternative scenario is better than the reference scenario
- However, only the introduction of **Fuel Cell vehicles** or **battery electric vehicles** lead to a significant reduction of GHG emissions as well as energy use
- **BEV** show a very similar effect on GHG emissions as **FCV** with even lower energy consumption

Due to still significant difficulties of battery electric vehicles, **Fuel Cell vehicles** are the only mid term alternative for sustainable mobility

Thank you!