Cycle beating:

How are OEM's optimising the vehicle to test cycles? Who does what in the homologation process?

GFEI – Green Global NCAP labelling / green scoring workshop

"Clean Vehicle Scoring System – How to Define What is a Clean Car?"

30th April 2013

Prof. Dr.-Ing. Reinhard Kolke, ADAC Technik Zentrum

ADAC Technik Zentrum

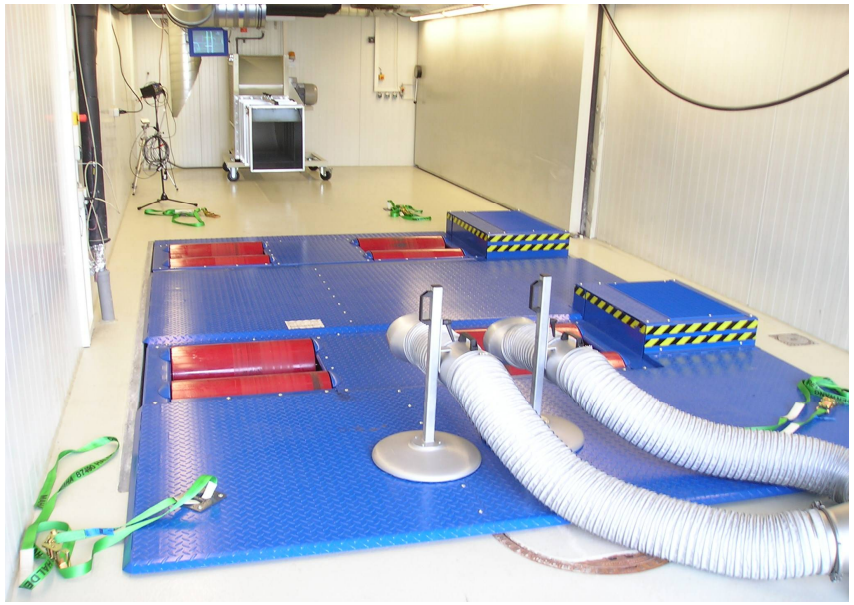
- ADAC is the worlds 2nd largest automobile club with more than 18.4 m members enjoying the status of a consumer protection organisation
- ADAC Technik Zentrum:
  Test centre of the European FIA clubs
- Emission tests, car reviews, crash tests, product tests, total cost of ownership, etc.
- What does consumer protection mean?
  - no commercial interest in products
  - neutral publication
  - focus on product improvement

The players
in consumer protection:

FIA partner clubs , EU,
Federal Government, ICRT

Example:
European Test Consortium
for Child Restraint Systems

ADAC emissions lab and low-temperature dynamometer



Emissions lab

- Temperature range: -10°C to +40°C
- max. speed 200 kph
- Simulation of uphill sections (up to 20%)
- CO, HC, CH_4, THC, NMHC, NO_x, NO, NO_2, PM, PN, CO_2
- official type approval lab

Low-temperature dynamometer

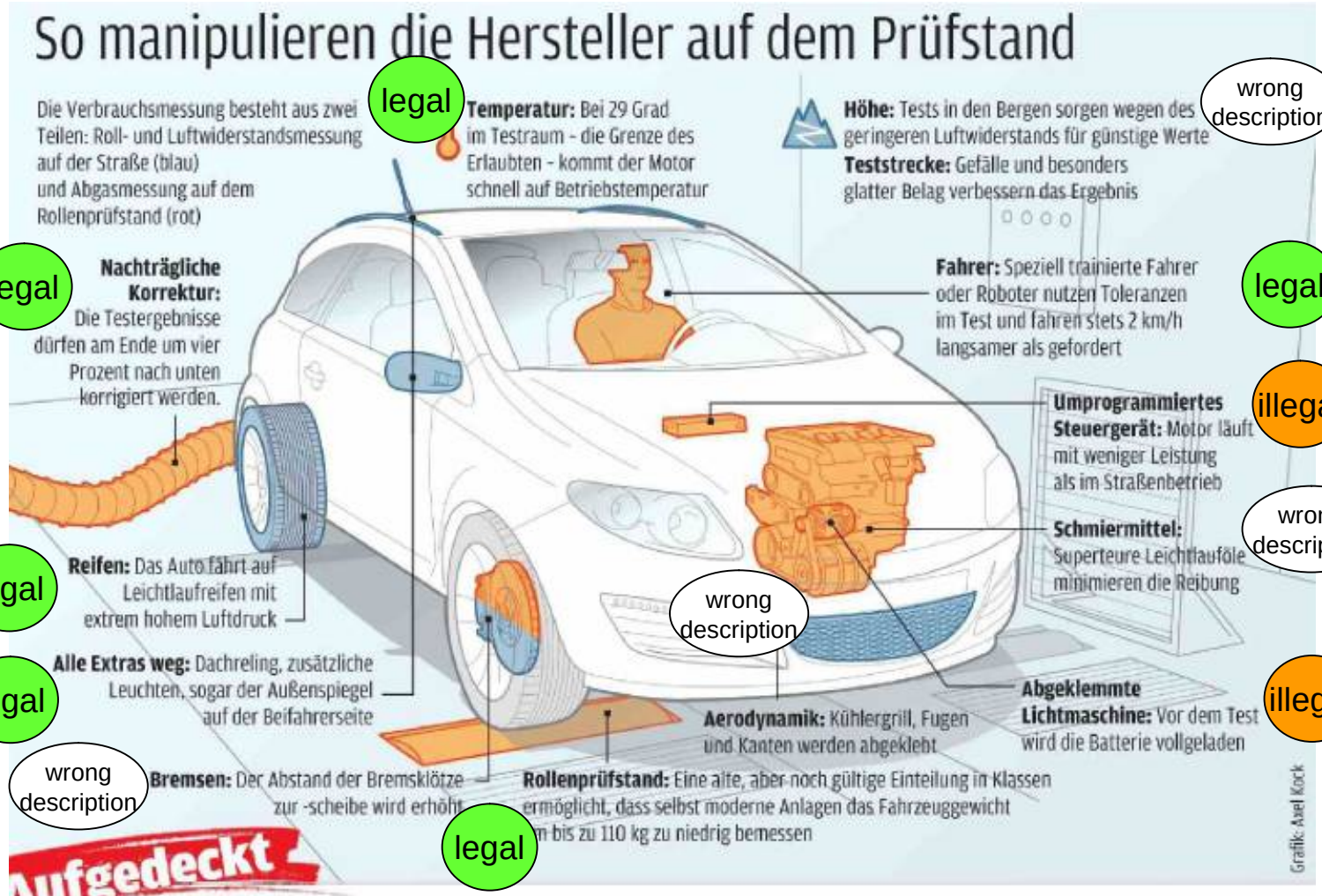
- Temperature range: -25°C to +30°C
- Horsepower up to 2 x 260 kW (2 x 350 hp)
- max. speed up to 260 kph
- OBD data interface
- Variable wheelbase: between 2.36 and 3.36 m

The challenge for consumer protection:

1. What is manipulation? What is legal?
2. Who is responsible: Legislation or manufacturer?

Manipulated Fuel Consumption

Source AutoBild 19.4.13



legal
illegal
wrong description
Comments to AutoBild

Agenda

A	Limits and tolerances in fuel efficiency specifications è **Manufacturers' leeway**
B	ADAC EcoTest – Presentation è **Real information for end users/consumers**
C	ADAC EcoTest – Results è **How do manufacturers' specs hold up to emissions in real driving cycles**
D	Conclusions

Limits and tolerances in fuel efficiency specifications

Limits and tolerances – the background

- Discrepancies between manufacturer's specifications and actual fuel efficiency has been a frequent reason for litigation between consumers and manufacturers.
- When it comes to fuel consumption, we must distinguish between
  - manufacturer's specifications based a test cycle (NEDC – New European Driving Cycle) in line with EU Reg. 715/2007 (type approval)
  - the fuel consumption of a specific vehicle in real-life use in traffic
  - the fuel consumption of the specific vehicle in cause measured in a test cycle (NEDC – New European Driving Cycle) in line with EU Reg. 715/2007
- Whereas manufacturers' fuel efficiency specifications are verified under defined conditions in a lab, the fuel consumption observed by the motorist depends on personal driving styles, the speed profile, weather conditions, vehicle payload etc.

The fuel consumption observed in real-life traffic cannot be compared with manufacturers' fuel efficiency specifications.

Limits and tolerances in fuel efficiency specifications

Production tolerances

- According to EU Reg. 715/2007 with regard to determining fuel consumption and CO_2 emissions, the tolerance for CO_2 emissions in production cars **must not exceed 4 %**
- CO_2 emissions are directly correlated with fuel consumption
  ð the 4 % rule also applies to fuel consumption

- The EU Regulation may be applicable only to the type approval of new models, but in the end it also sets the **max. limit for CO_2 emission variation in production cars.**
- If state of the art means anything, the actual discrepancies should be below that limit.

Limits and tolerances in horsepower and fuel efficiency specs

Tolerances for fuel consumption measurements

Reasons

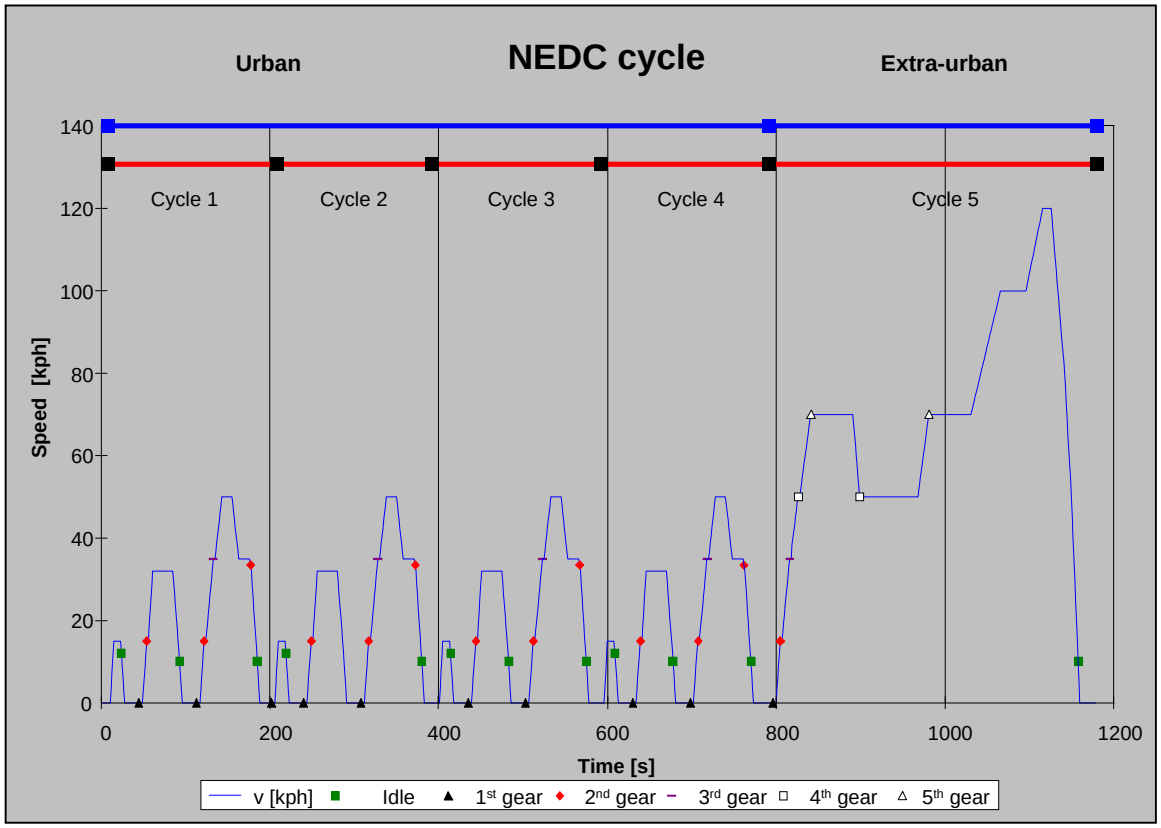
- Admissible bandwidth in defined measurement conditions, e.g.
  - Test bench temperature (between 20 and 30 °C)
  - Air humidity (altitude of test bench)
  - Position and specification of the wind machine
  - Level of discharge of the battery before and after the test
- Rolling resistance curve (data table instead of deceleration test data)
- Driver impact within the predefined limits
- Technical condition of vehicle, mass, tyres, standstill/idle periods
- Fuel quality, type of drum, measurement equipment (level of maintenance)

Many years of experience with the ADAC test bench have shown that

- Tolerances for tests under conditions in line with the type approval **do not exceed ±2 %**, as long as the testing conditions are not changed between tests **(** à **repeatability)**

Limits and tolerances in fuel efficiency specifications

Mandatory test procedure (NEDC)

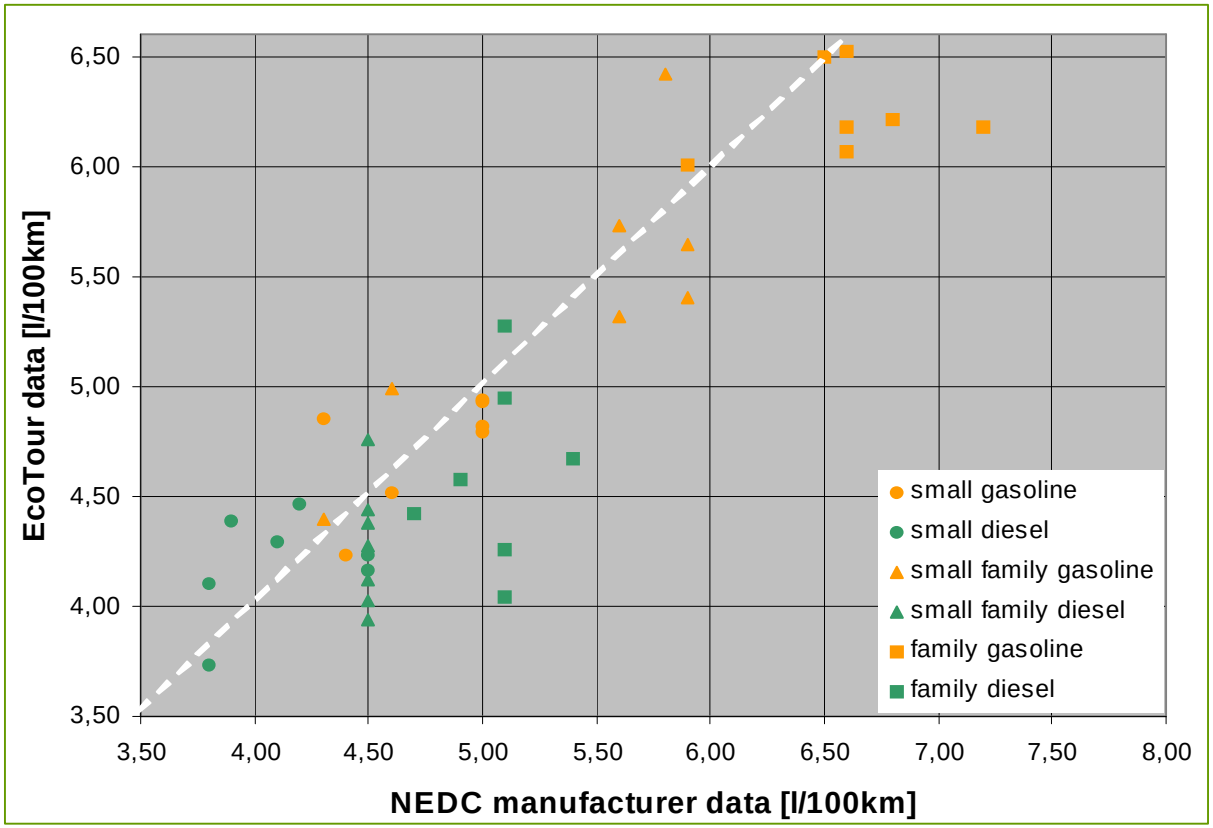


- The New European Driving Cycle (NEDC) has been in force since 1 January 1996; it consists of an urban and extra-urban component with a max. speed of 120 kph
- EU Reg. 715/2007: aims at verifying fuel consumption and CO_2 emissions
- Fuel consumption calculated from the amount of hydrocarbon emissions (CO, HC, CO_2)
- Certified EU testing labs ensure uniform and legally binding measurements
- In Germany, testing labs are accredited by the Federal Motor Transport Authority

- NEDC was developed to determine the amount of emissions.
- **It is adequate for the comparative assessment of cars.**

Limits and tolerances in fuel efficiency specifications

Empiric fuel consumption data –
EcoTour 2008: 42 vehicles – 9 countries – 2,800 km

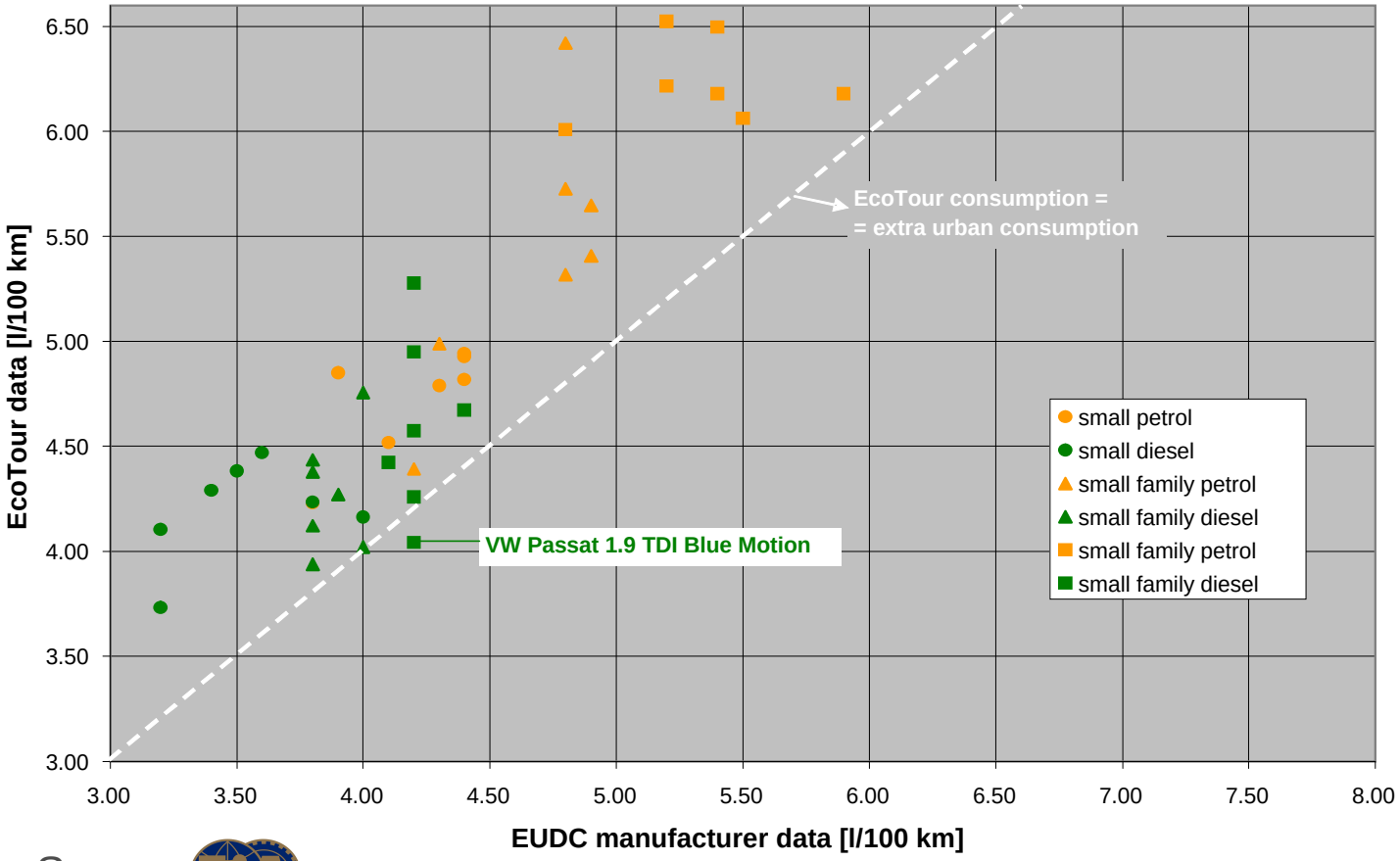


Results:

- Mindful driving can beat manufacturer's specifications
- Fuel efficiency can be 20 % better than manufacturer's specifications
- It is easier to drive fuel-efficiently with larger cars

Limits and tolerances in fuel efficiency specifications

Empiric fuel consumption data –
EcoTour 2008: 42 vehicles – 9 countries – 2,800 km



Source: FIA

- The EcoTour driving profile resembles the extra-urban section of the NEDC
- Hardly any vehicle was able to beat manufacturer's specs for extra-urban driving even where the drivers employed extreme eco-driving techniques
- The values of the NEDC extra-urban cycle can hardly be matched
- Calls for revising the NEDC extra-urban cycle

Limits and tolerances in fuel efficiency specifications

Summary

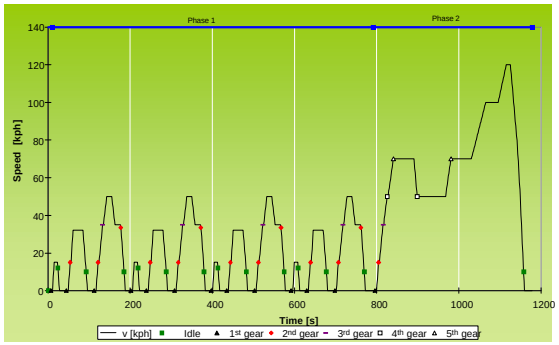
- Where **all the leeway granted under the type approval and the admissible tolerances** are taken advantage of to the fullest, **discrepancies in** fuel efficiency **of up to 20 %** are possible.
  - ADAC metering conducted under the *Autotest* car review and the EcoTest programmes have shown that discrepancies of this magnitude are not unheard of.
- The technical possibilities of state-of-the-art test benches allow us to define test conditions much more precisely.
  - The procedure defined in the EU regulation concerning the verification of pollutant emissions is inadequate since the leeway it grants defeat the purpose of comparative verification of fuel consumption.
  - In litigation, the test conditions of the initial test must be matched exactly to ensure **comparability**.

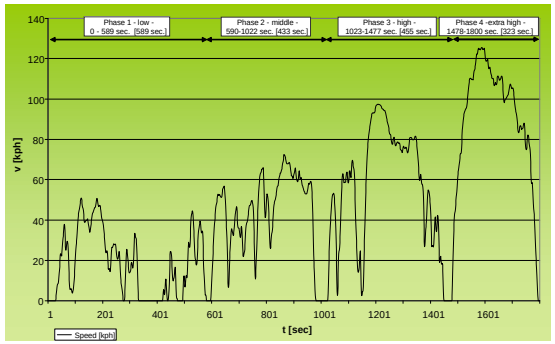
ADAC EcoTest

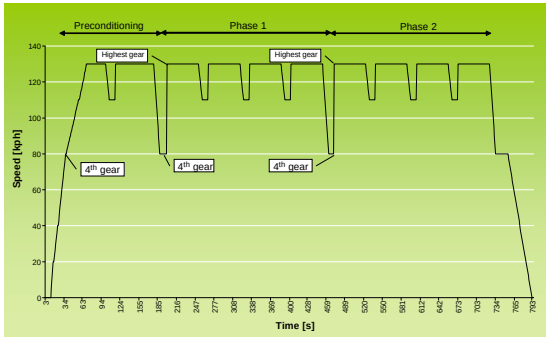
- Has provided comprehensive consumer information regarding the eco-friendliness of vehicles since 2003.
- Assessment of fuel consumption (CO_2 emissions) and pollutant emissions.
- Based on specially developed real-life driving cycles, which go beyond the mandatory type approval test cycles.
- Objective: innovation, light-weight design and fuel efficiency across all vehicle classes
- **Manufacturers use EcoTest as a standard and include the test label in their advertising**
- **All consumer tests, like EcoTest, needs to be adjusted regularly. Moving target!**
- Assessments of over 1,200 tested cars are available. 150 vehicles are tested annually.
- Adjustment of the test and rating criteria as from April 2012:
  - Inclusion of the WLTP cycle (the coming world-wide test cycle)
  - Well-to-wheel assessment for better comparability of electric vehicles
  - Electric cars are assessed on the basis of the energy consumed (kWh) incl. self-discharge and the CO_2 emissions from power plants based on the German (D) electricity mix (Source: Federal Environment Agency, UBA) and renewable energies
  - Stricter CO_2 limits
  - Adjustment of pollutant assessment to Euro 6 (petrol engines)
  - Measurement and assessment of the particle number

EcoTest test cycles

- **NEDC cold**
  Initial assessment; testing for pollutants such as HC, CO, NO_x, particulate matter and NEW! the particle number of diesel and direct-injection petrol engines; NEW! daytime running lights (if present) or low beams are on during test; CO_2 testing
- **WLTP**
  “World cycle” replaces NEDC hot; with air conditioning on and NEW! daytime running lights (if present) or low beams are on during test; CO_2 testing
- **ADAC Motorway test**
  With air conditioning on and NEW! and daytime running lights (if present) or low beams on during test; testing for pollutants such as HC, CO, NO_x, particulate mass; CO_2 testing

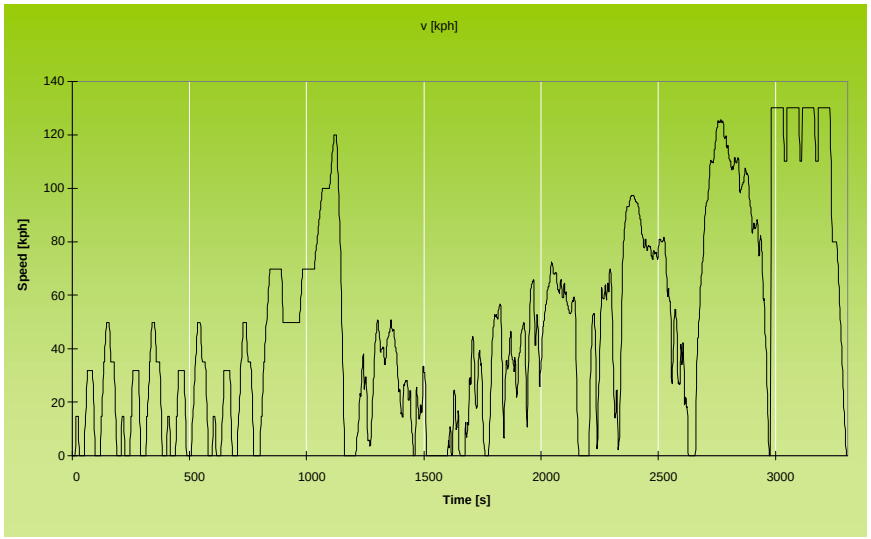






EcoTest test cycles

- **Petrol and diesel vehicles**
  No special sequence
- **LPG/CNG vehicles**
  NEW! EcoTest is run only on LPG/CNG drive
- **Hybrids**
  Battery state of charge (SOC) 60-70 %
- **Plug-In-hybrids**
  Measurement of full battery and measurement of empty battery – standard averaging; measurement of the charge (energy input) in kWh and calculation of CO_2 emissions (1 kWh= 563 g/kWh; Source: UBA; this value is corrected as needed)



- **Electric vehicles**
  Measurement in electric vehicle cycle (all three cycles back to back) until SOC < 50 %; measurement of the charge (energy input) in kWh and calculation of CO_2 emissions (1 kWh= 563 g/kWh; Source: UBA; this value is updated as needed); power plant emissions are not relevant

EcoTest rating

EcoTest

Pollutant rating (absolute)	**CO_2 rating** (well-to-wheel, class-dependent scale)	**Additional information provided: Fuel consumption**

EcoTest rating – 5-star rating system

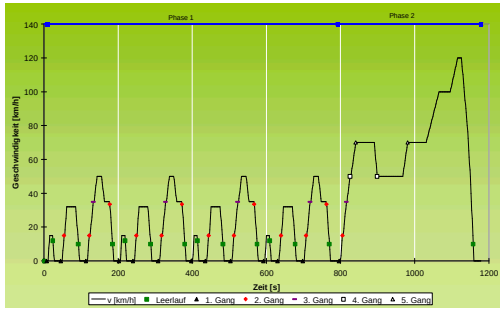
Small ecological footprint

Large ecological footprint

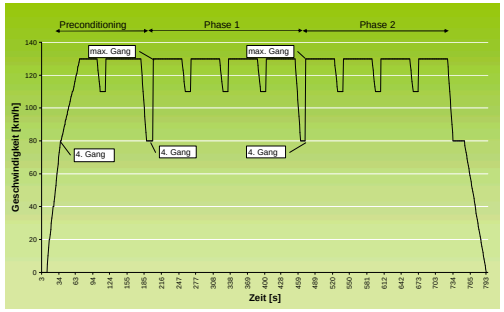
≥90	★★★★★
70...89	★★★★☆
50...69	★★★☆☆
30...49	★★☆☆☆
<30	★☆☆☆☆

Pollutants rating

NEDC cold



ADAC Motorway



PM / PN — 50% Worst Case

HC / NOx / CO — 50% Worst Case

→ 70%

PM — 50%

HC / NOx / CO — 50% Worst Case

→ 30%

Pollutant rating (absolute)

Pollutants rating – thresholds

	NEDC		ADAC Motorway	
	★★★★★	★☆☆☆☆	★★★★★	★☆☆☆☆
	50 points for [g/km]	10 points for [g/km]	50 points for [g/km]	10 points for [g/km]
HC	0.10 a)	0.20 d)	0.10 a)	0.20 d)
CO	0.50 b)	1.00 e)	0.50 b)	7.00 c)
NOx	0.06 a)	0.25 f)	0.06 a)	0.70 c)
PM	0.003 c)	0.015 c)	0.003 c)	0.015 c)
PN	6E+10 c)	6E+12 g)		

a) Euro 6 petrol

b) Euro 6b diesel

c) ADAC EcoTest

d) Euro 3 petrol

e) Euro 4 petrol

f) Euro 4 diesel

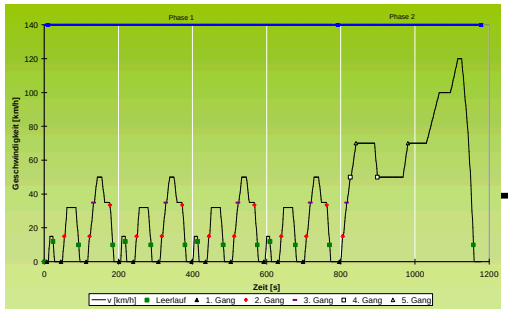
g) possibly OBD GW

§ All types of drives or fuels are equal in ADAC EcoTest.

Unlike under current legislation, no bonus for diesel engines applies in ADAC EcoTest.

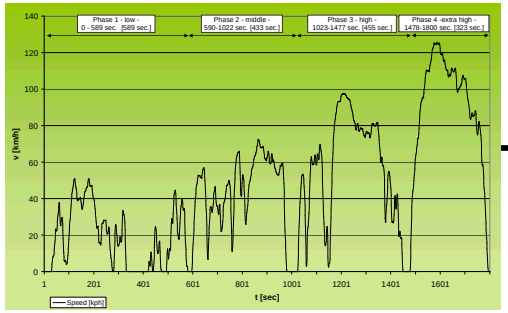
CO_2 rating

NEDC cold



50%

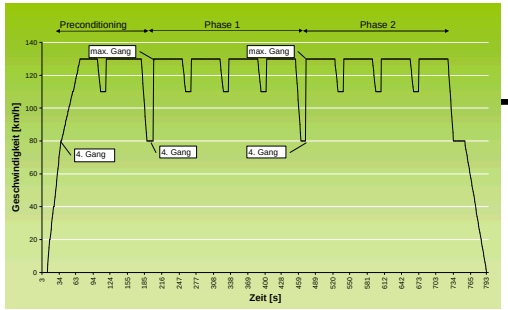
WLTP



50%

70%

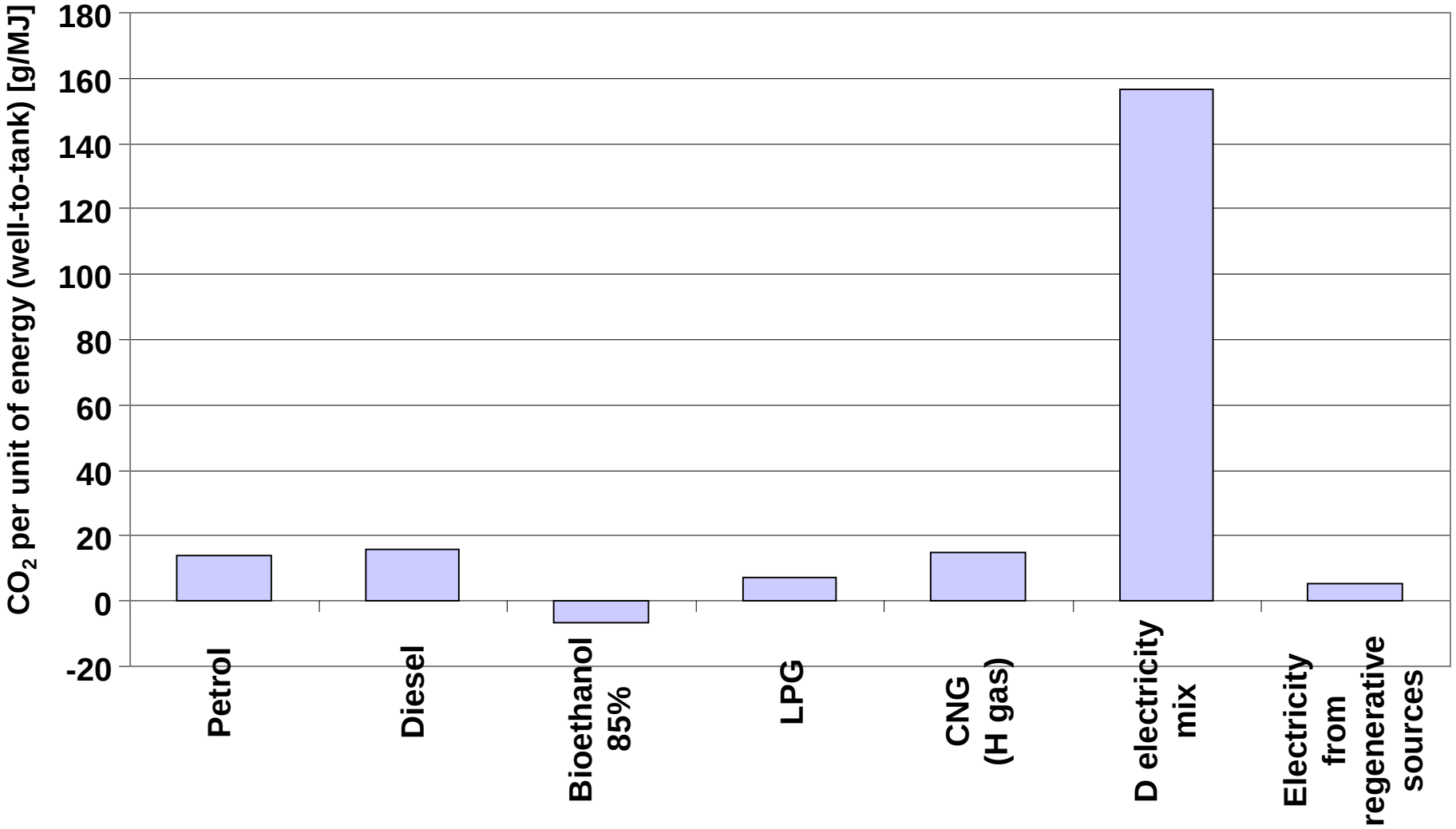
ADAC Motorway



30%

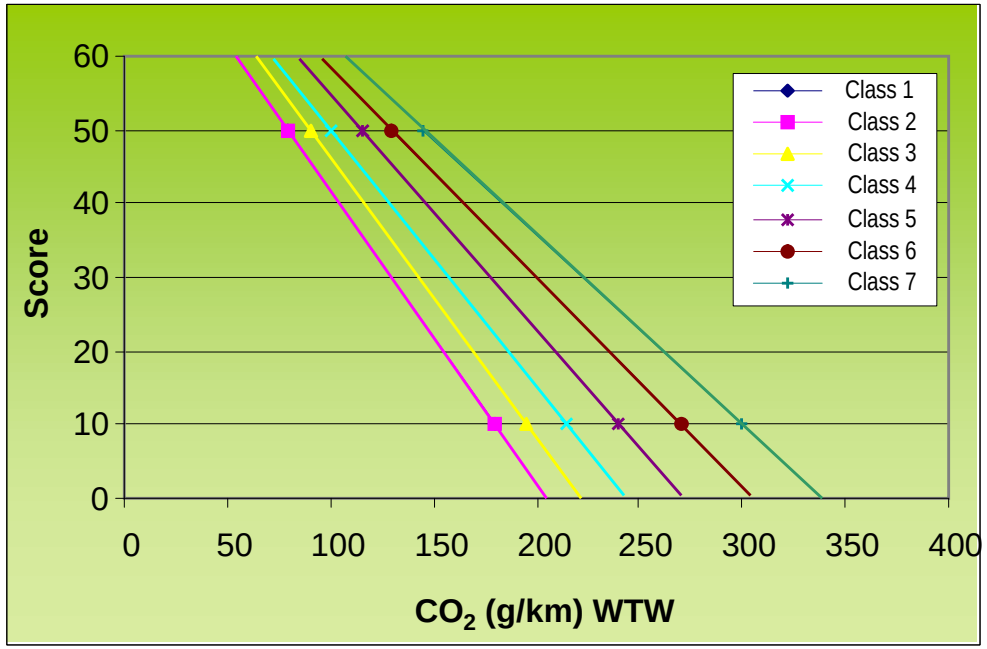
CO_2 rating
(well-to-wheel, class-dependent)

CO_2 emissions in energy generation per unit of energy



CO_2 rating – thresholds, well-to-wheel

Vehicle class	★★★★★ 50 points for [g/km]	★☆☆☆☆ 10 points for [g/km]
1	80	180
2	80	180
3	90	195
4	100	215
5	115	240
6	130	270
7	145	300



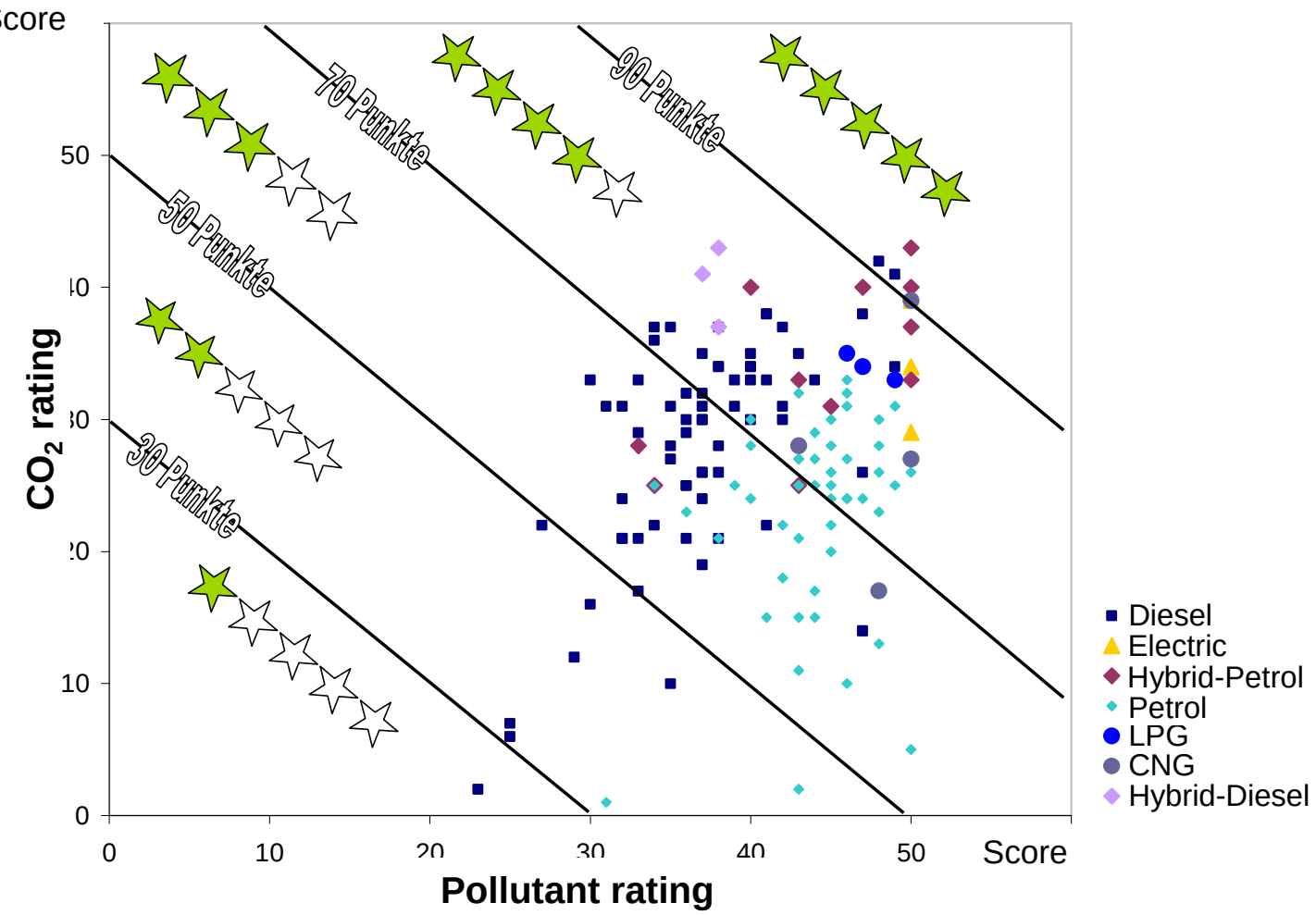
§ CO_2 ratings are based on a system of relative class-dependent scales.

The ADAC EcoTest offers consumers useful information for comparing vehicles of the same size and vehicle class.

CO_2 rating – vehicle classes and sample cars

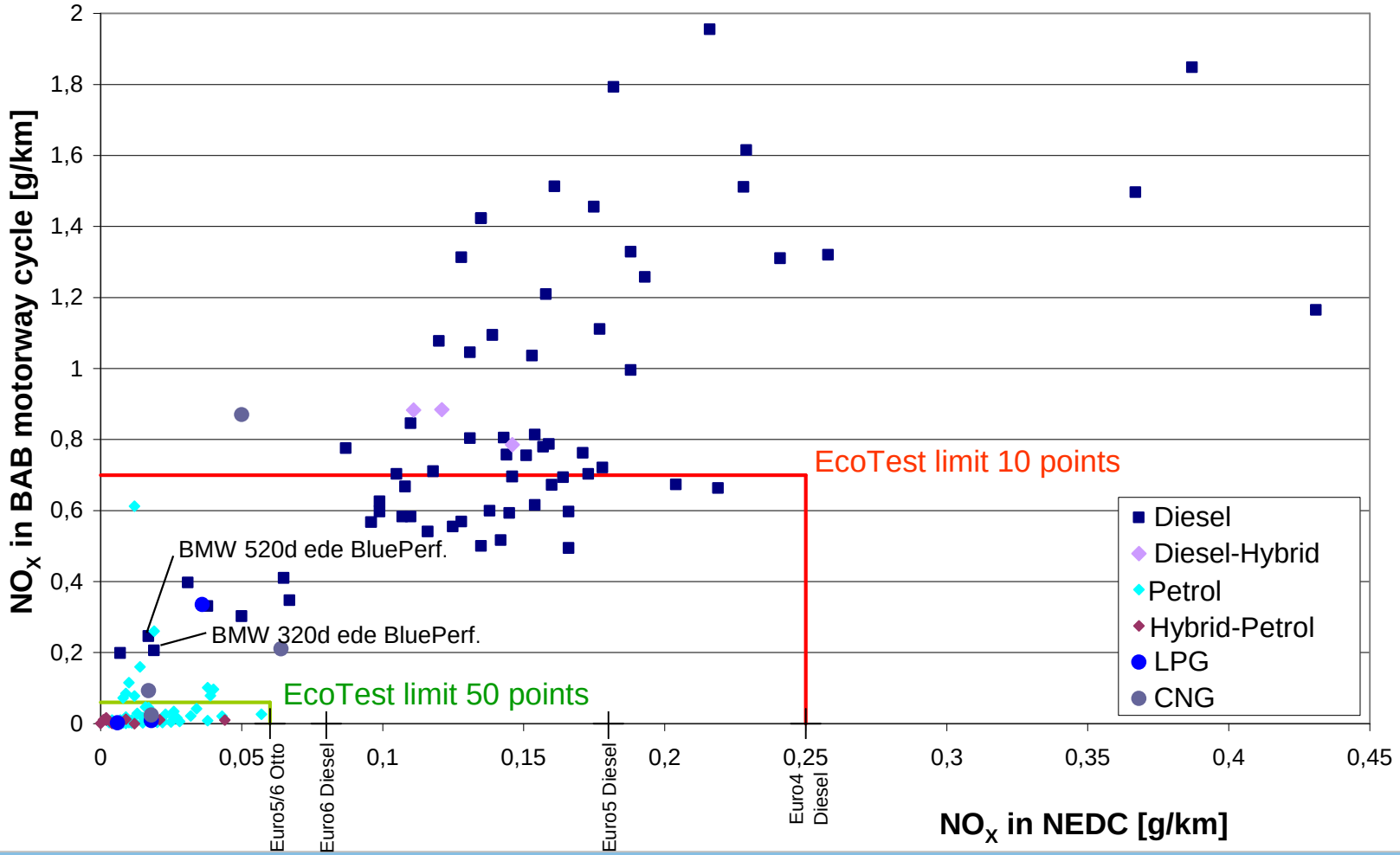
No.	Vehicle class	Examples
1	Microcar	Smart
2	City	Fiat 500, Peugeot 107, VW up!
3	Supermini	Ford Fiesta, Peugeot 208, VW Polo, Audi A1
4	Small family	Mercedes A-Class, Toyota Auris, VW Golf
5	Family	3-series BMW, Mazda 6, Opel/Vauxhall Insignia, Toyota Avensis
6	Executive	Audi A6, 5-series BMW, Mercedes E-Class, Volvo V70
7	Luxury	Audi A8, 7-series BMW, Mercedes S-Class

Overall EcoTest results



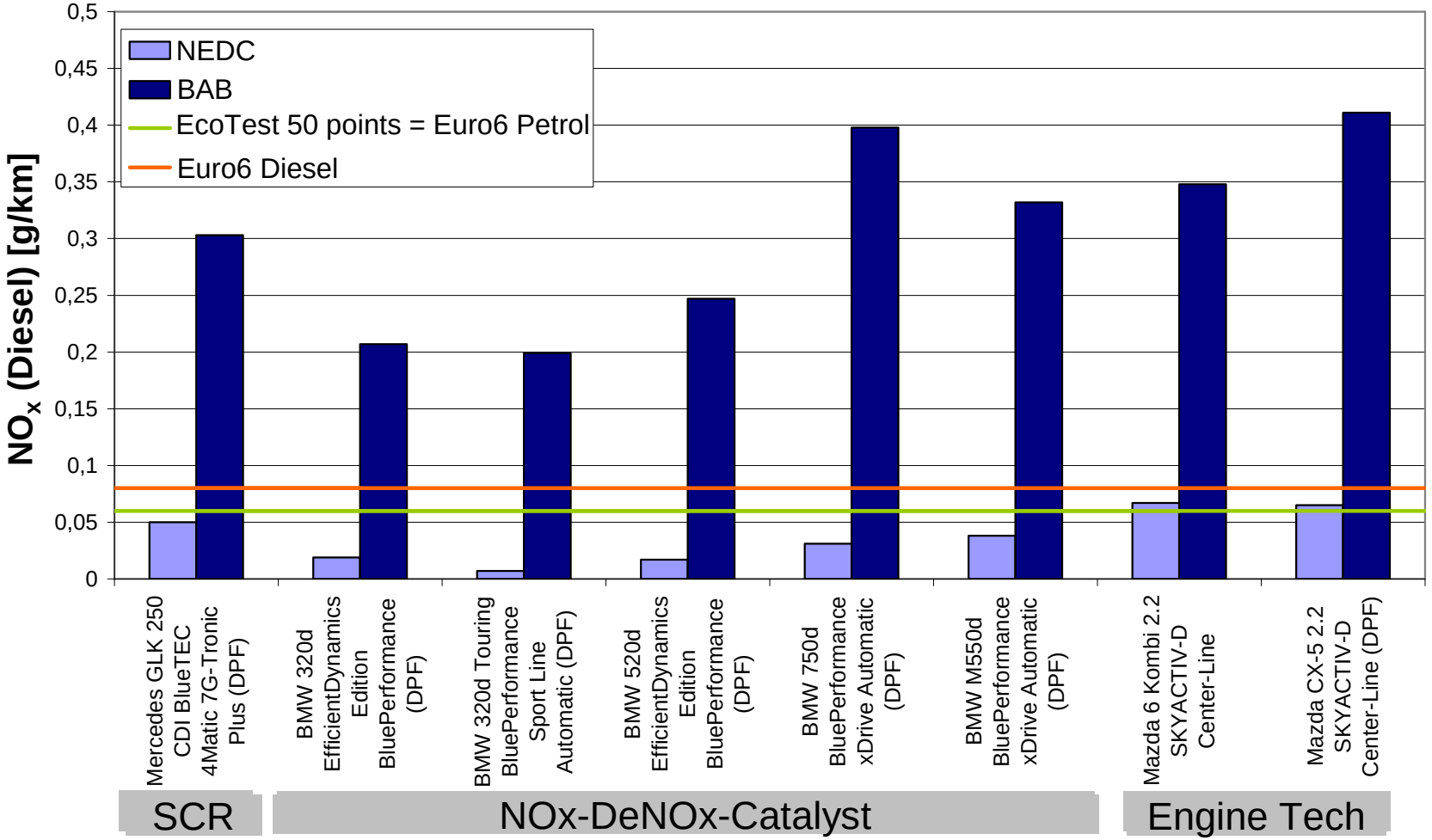
The first cars tested to 5-star ratings in ADAC EcoTest:
Toyota Prius 1.8 hybrids & 1.8 Plug-In hybrids; BMW 320d ede BluePerf. & 520d ede BluePerf.

NO_x emissions in EcoTest: NEDC vs. BAB motorway cycle



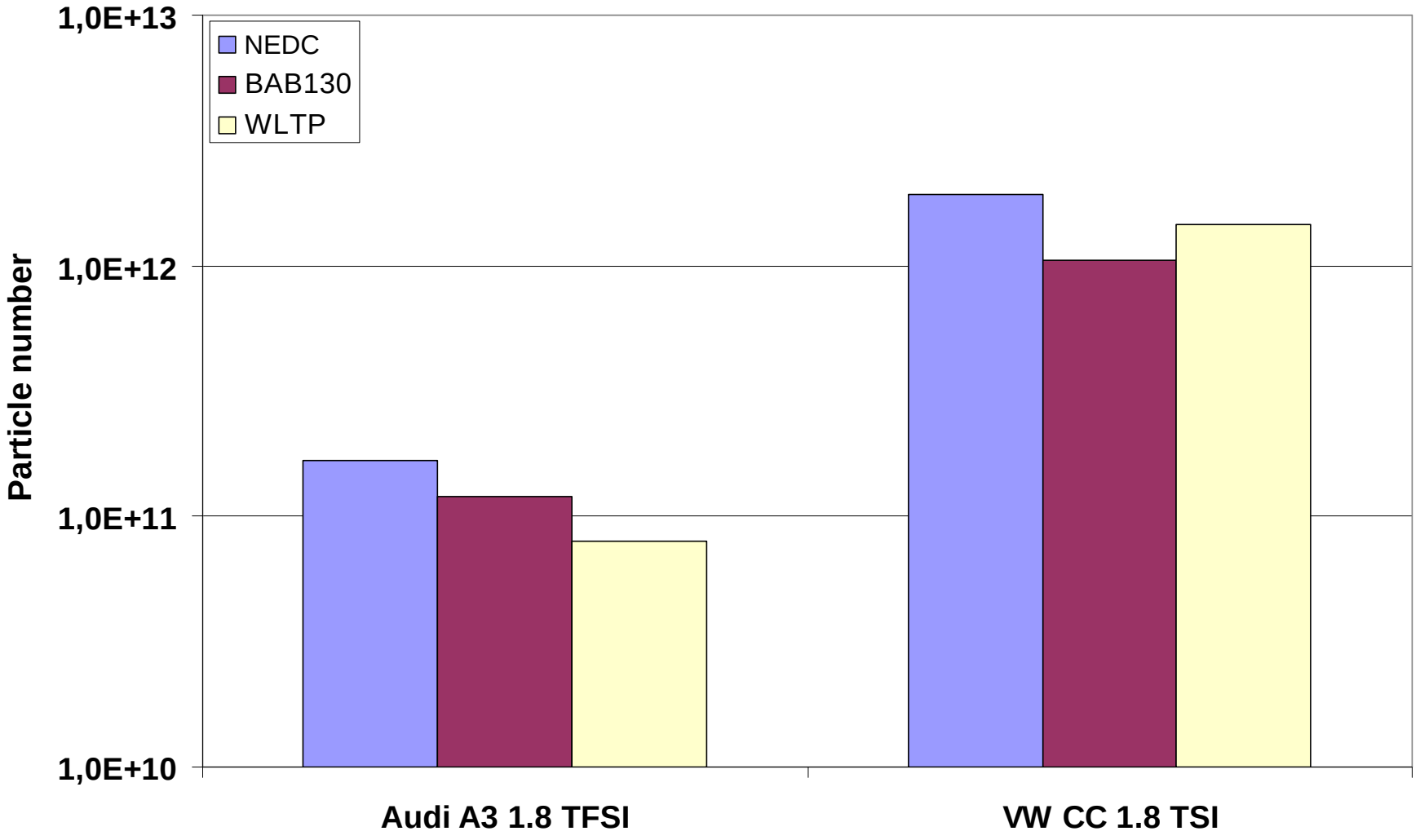
EcoTest ensures that vehicles meet emission standards not only in the mandatory type approval test cycle but also in real-life traffic conditions.

NO_x emissions in EcoTest: Performance of various exhaust after-treatment systems

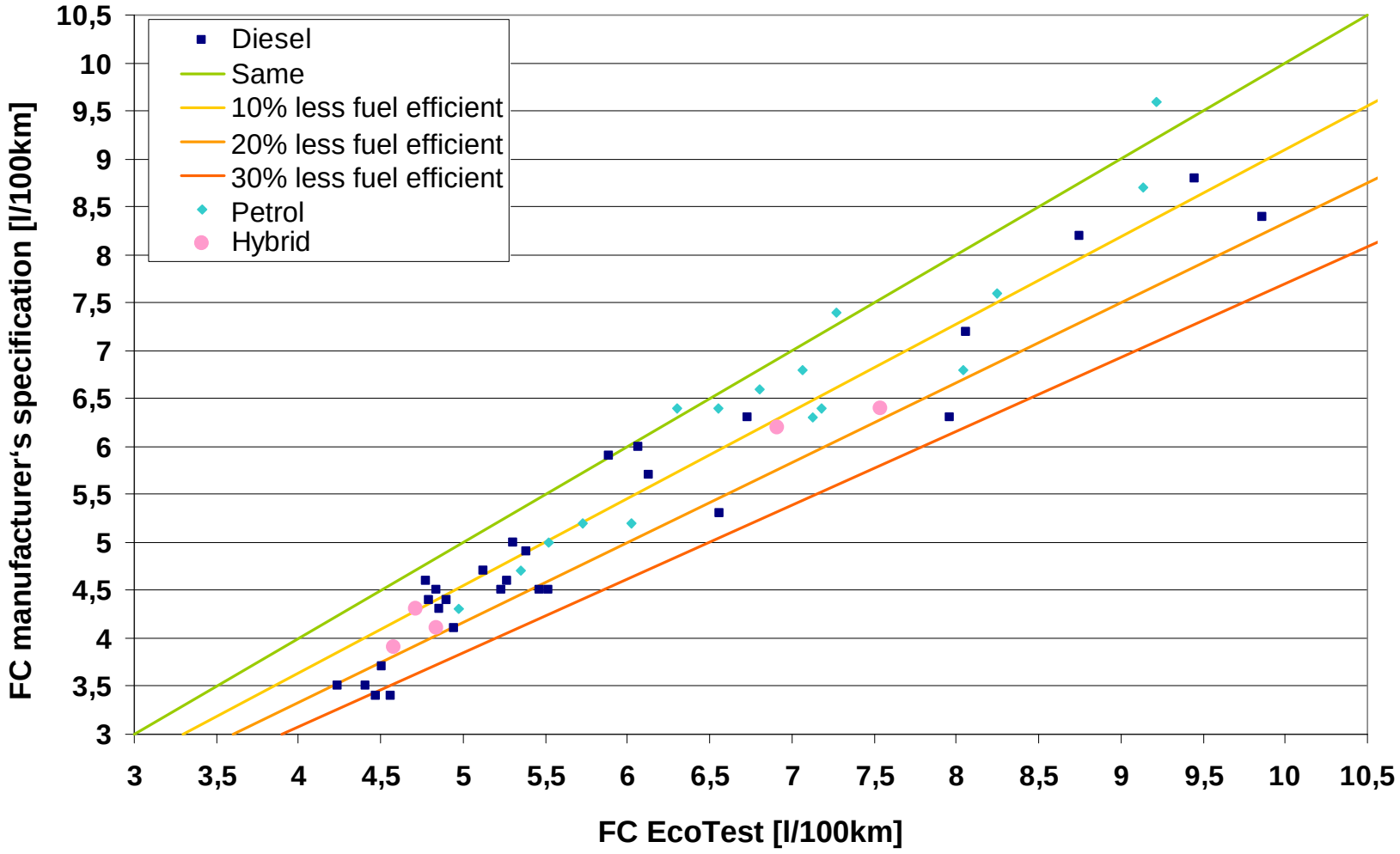


Outside the NEDC parameters NO_x emissions are clearly higher.
Some exhaust after-treatment systems also work better under these conditions.

Test results for particle numbers of DI petrol engines in NEDC, WLTP and ADAC BAB motorway cycle

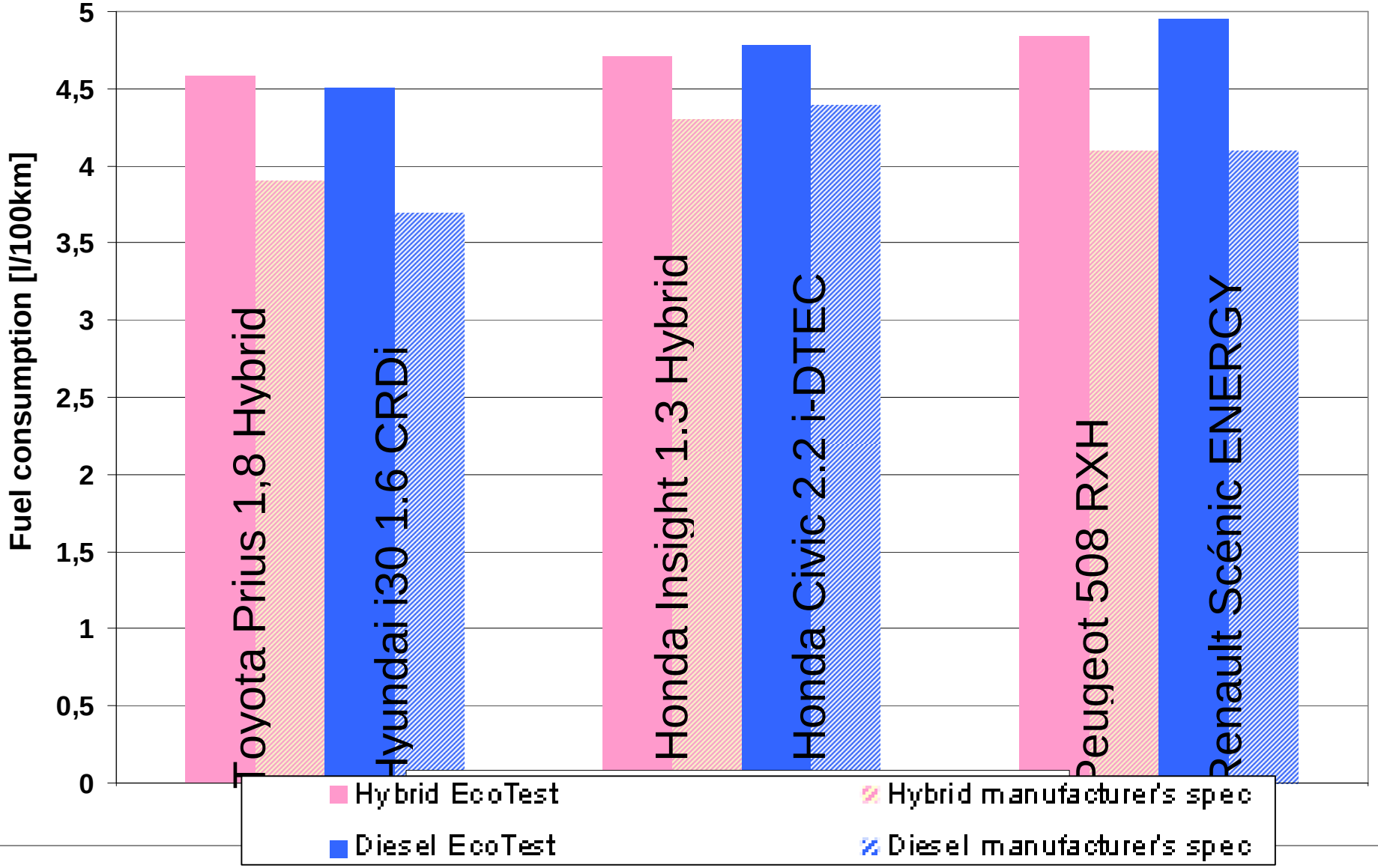


Fuel consumption in EcoTest vs. manufacturer's specifications

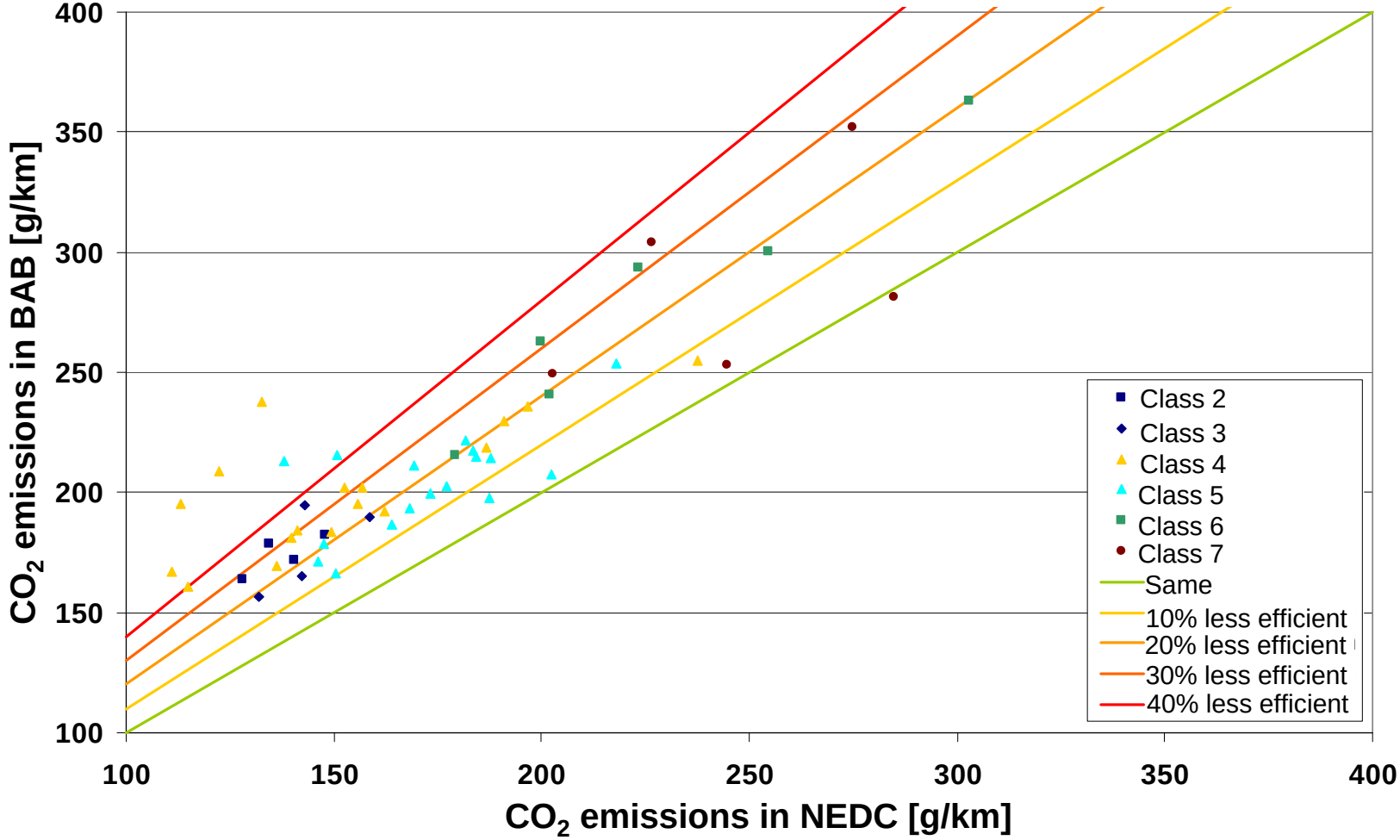


With the exception of EcoTest, all popular eco-friendliness car ratings are based on manufacturer's specifications and thus do not reflect actual fuel consumption.

Fuel consumption in EcoTest vs. manufacturer's specifications – hybrid vs. diesel

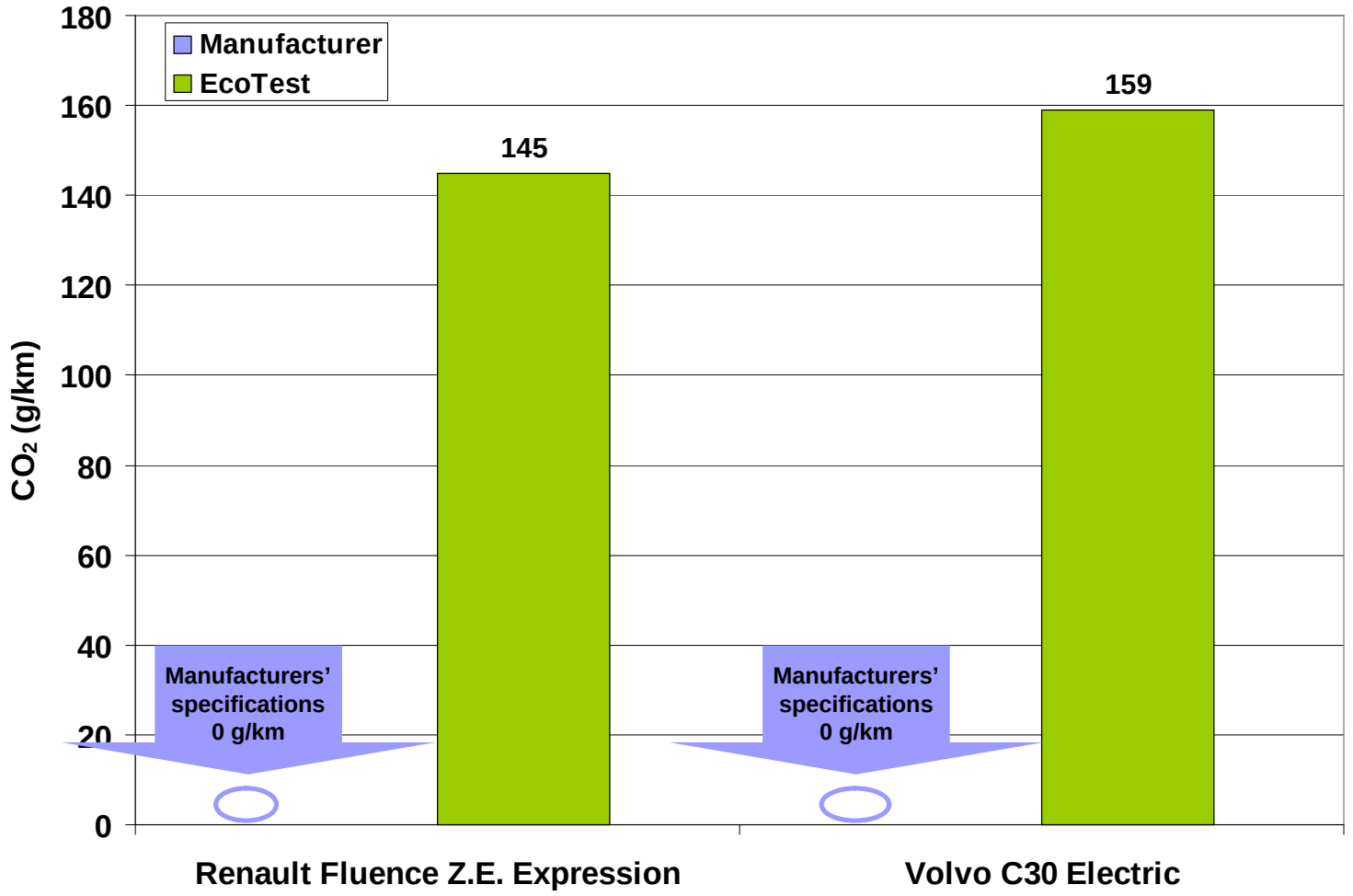


CO_2 emissions in EcoTest: NEDC vs. BAB motorway cycle



Usually, CO_2 emissions outside the NEDC are clearly higher.

CO_2 emissions in EcoTest vs. manufacturer's specifications



The EcoTest CO_2 results of electric cars may considerably depart from manufacturers' specifications due to energy generation and driving cycles.

Conclusions

- Due to variables in production, there are discrepancies between the type approval/manufacturer's fuel consumption specifications and the actual fuel consumption of production cars.
- The state of the art in bench testing ensures that under the same test conditions tolerances are within a 2 % margin.
- Discrepancies of up to 20 % are possible if all the leeway granted under the Directive and the admissible tolerances are taken advantage of to the fullest.

- We cannot allow that the leeway afforded by regulation be used to the detriment of the consumers.
- The new driving cycle known as Worldwide Harmonized Light Vehicles Test Procedure (WLTP), which is currently under development by the United Nations Economic Commission for Europe (UNECE), should be implemented as soon as possible.
- The ADAC EcoTest offers more realistic emission and fuel consumption data for consumers.

Thank you very much for your attention!