



EcoTest

Testing and Assessment Protocol Release 2.0

Programme Manager
Dipl.-Ing. (FH) Sonja Schmidt
ADAC Technik Zentrum



FIA Foundation
for the Automobile and Society



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1 Introduction

The EcoTest is designed to provide a fair, meaningful and objective assessment of the environmental performance of cars. It is intended to inform consumers, so providing an incentive to manufacturers as well as giving credit to those who excel at environmental behaviour. The tests are based on those developed for emission legislation in Europe and extended by procedures and parameters to cover a wide range of real driving in Europe.

No stylised test procedure fully reflects the environmental impact of a car in the wide variety of driving behaviours. However, cars that perform well in these tests should provide less environmental impact than cars which perform less well.

2 Testing Protocol

To provide reproducible test conditions the EcoTest is based on driving cycle measurements on a chassis dynamometer.

During all driving cycles the emissions of carbon monoxide (CO), carbon dioxide (CO₂), total hydrocarbons (HC), nitrogen oxides (NO_x) and particles (PM) are measured integrally. The fuel consumption is determined by the carbon containing emission components.

The road load (homologation values) is provided by the vehicle manufacturers.

2.1 New European Driving Cycle (NEDC)

The NEDC is the basis for the homologation of cars. As for the EcoTest one specific car is measured the results of the NEDC measurement are compared with the homologation values to ensure the indisputable condition of the vehicle.

The exhaust emissions are measured during the “New European Driving Cycle” (NEDC) according to directive 98/69/EC. The NEDC is shown in **Figure 1**.

The first part represents urban driving, in which a vehicle is started in the morning (after being parked all night - only in cold test) and driven in stop-and-go rush hour traffic. The second part represents extra-urban driving with a maximum speed of 120 km/h.

For all tests the adjustments are in accordance with directive 70/220/EC.

2.1.1 NEDC Cold Test

This test is used to evaluate:

- pollutants
- CO₂
- fuel consumption

The vehicle's engine temperature is 22°C ± 2°C before starting the NEDC cold test. The soak time is at least 6 hours and maximum 30 hours.

This test cycle is to control the condition of the vehicles. Therefore the measured data will be compared with the manufacturer's specifications.

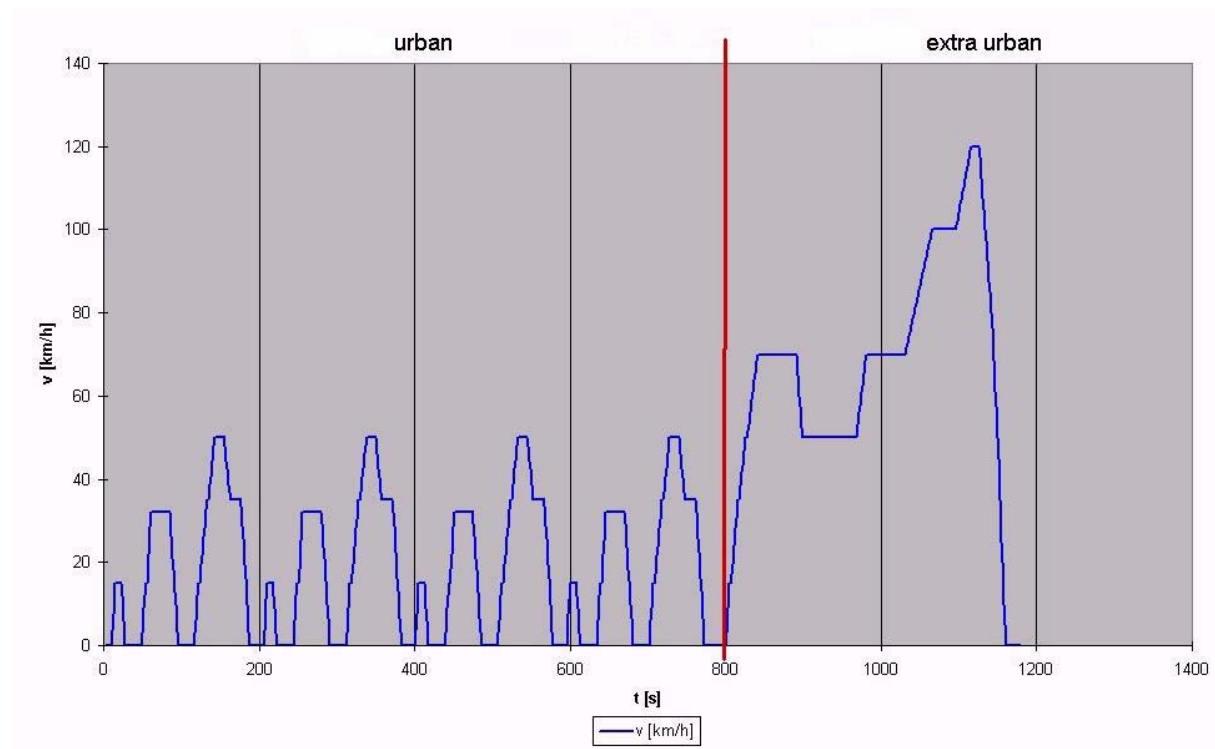


Figure 1: New European Driving Cycle

2.1.2 NEDC Hot Test

This test is used to evaluate:

- CO₂
- fuel consumption

For the NEDC hot test the vehicle oil temperature is approx. 90°C before starting the test procedure.

The temperature of the testing room is set to 22°C ± 2°C.

Normally for emission tests made after EU regulation all energy consuming aggregates such as air conditioning have to be switched off. This hot test is intended to more closely replicate consumer's behaviour.

Adjustment of Manually Controlled Air Conditioning

- A/C Button: on
- Temperature selector: about 20°C; temperature measured near between drivers and co-drivers head position
- Fan speed selector: 1/3 ... 1/4
- Air flow selector: Floor/ Windshield; (alt.: Bi-level; the air flows both from the floor vents and the instrument panel vents.)

Adjustment of Automatically Controlled Air Conditioning

- A/C Button: on
- Temperature selector: 20°C
- Fan speed selector: AUTO

- Air flow selector: Floor/Windshield; (alt.: Bi-level; the air flows both from the floor vents and the instrument panel vents.)

2.2 ADAC Highway Driving Cycle

With the ADAC Highway Driving Cycle the EcoTest covers a wide range of typical driving situations. The cycle was developed by ADAC and shows good accuracy for European highway driving. The air conditioning as a typical standard equipment in Europe is switched on.

This test is used to evaluate:

- pollutants
- CO₂
- fuel consumption

The ADAC highway cycle enables to detect if the exhaust emission control system also performs well outside the EU homologation cycle NEDC.

For the ADAC highway test the vehicle oil temperature should be approx. 90°C before starting the test procedure.

Due to the fact that 130 km/h is the speed limit on highways in many European countries, the maximum speed in the highway driving cycle is limited to 130 km/h. In addition the ADAC highway cycle includes full-load acceleration.

The adjustment of the air conditioning for ADAC highway tests is similar to the NEDC hot test with air conditioning on.

The highway driving cycle is shown in **Figure 2**. The ratings are based on the average of Phase 1 and Phase 2 performance of the cycle.

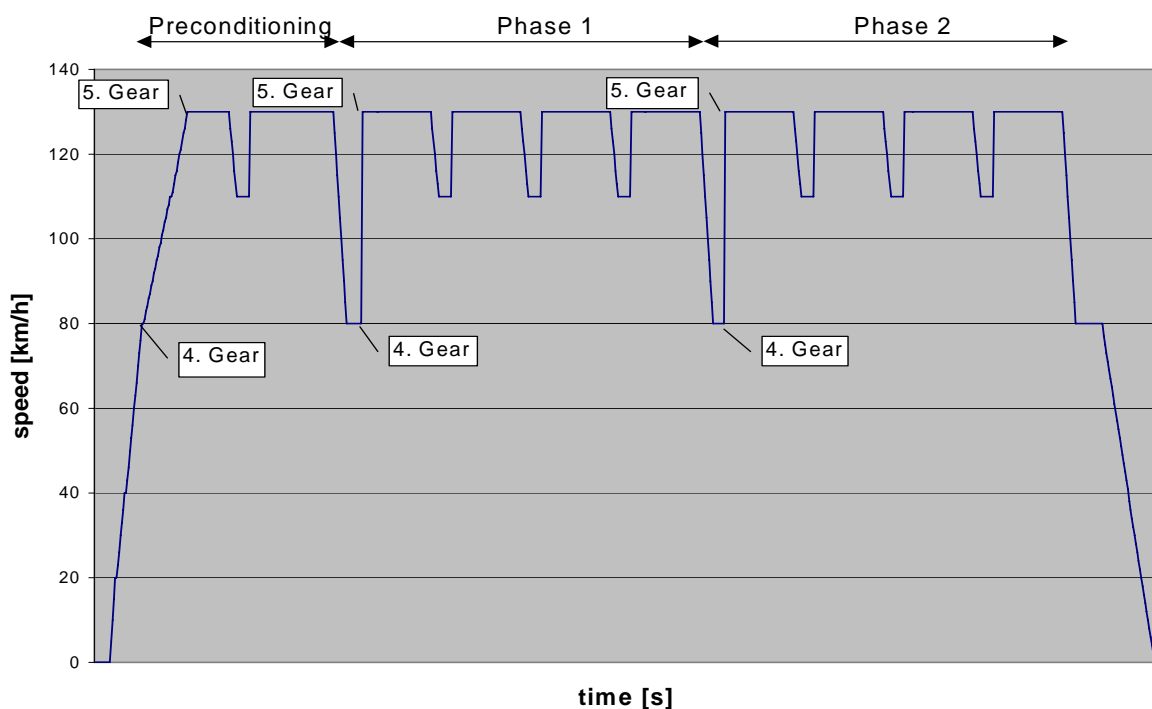


Figure 2: ADAC Highway Driving Cycle

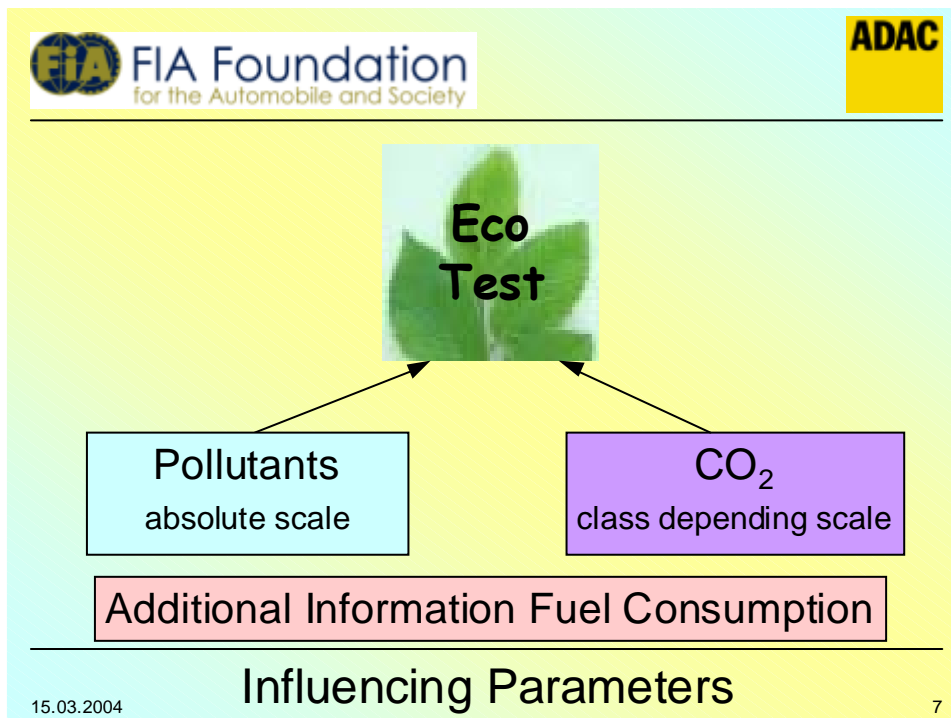


Figure 3: The calculation of the EcoTest rating

3 Assessment Protocol

The EcoTest scores are calculated by the contributions of pollutants and CO₂ ratings. Each partial result is kept with two decimals for further calculation. Fuel consumption is also provided as shown in **Figure 3**.

The EcoTest rating is calculated according to formula (1):

$$Rating_{EcoTest} = Rating_{pollutants} + Rating_{CO_2} \quad (1)$$

The EcoTest rating assesses the environmental impact of each tested car according to **Figure 4**. The ratings for pollutants and CO₂ are calculated with the corresponding measured values on the base of dedicated scales.

For the rating of pollutants absolute scales are used, which are independent of the vehicle classes. For the CO₂ rating relative scales based on the vehicle classes are used.

Table 1 shows the vehicle classes that are being used, together with examples of the type of vehicle in each class.

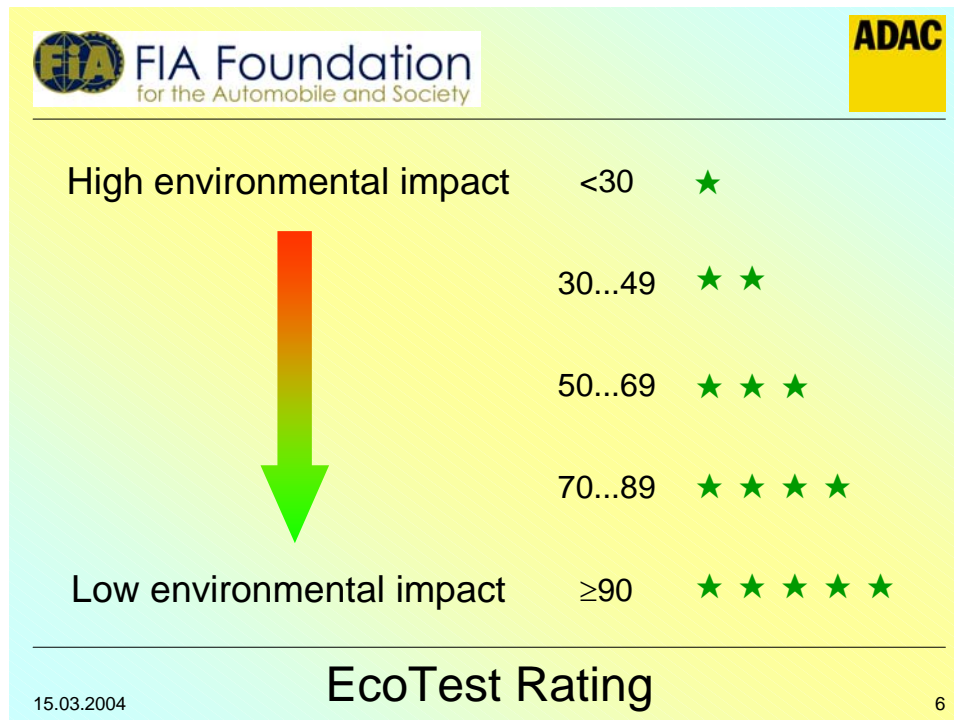


Figure 4: EcoTest star rating

3.1 Pollution

The ratings are based on a linear scale system, defined by thresholds for 10 points and 50 points, respectively. According to the measured value a score between 0 and 50 points can be achieved.

The rating of the pollutants is calculated by contributions of the ratings of NEDC cold and ADAC highway. Although conventional Petrol engines, except direct injection systems, do not have particle emissions detectable by gravimetric measurements, the same rating formula (2) for Petrol and Diesel vehicles is used. The consequence is that Petrol vehicles (except direct injection engines) have the maximum rating for particles which influences the emission-result positively. This scheme is shown in **Figure 5**.

Table 1: Vehicle classes

ID	Vehicle class	Example
1	City (two seats)	Smart
2	City	Fiat Seicento, Peugeot 106, VW Lupo
3	Supermini	Fiat Punto, Peugeot 206, VW Polo
4	Small Family	Toyota Corolla, VW Golf
5	Family	BMW 3-series, Mazda 6, Opel Vectra, Toyota Avensis
6	Executive	Audi A6, BMW 5-series, Mercedes E-class, Peugeot 607
7	Luxury	Audi A8, BMW 7-series, Jaguar XJ, Mercedes S-class

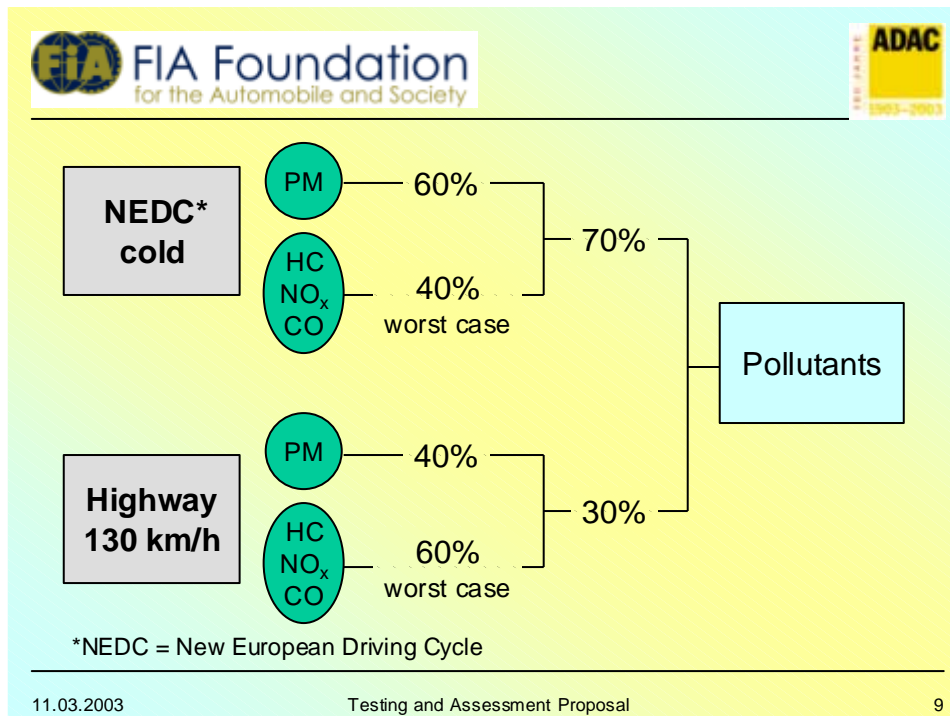


Figure 5: Scheme for the rating of pollutants

$$\begin{aligned}
 Rating_{pollutants} = & 0.7 \cdot (0.6 \cdot Rating_{NEDC\ cold\ PM} + 0.4 \cdot Rating_{NEDC\ cold\ worst\ case}) + \\
 & + 0.3 \cdot (0.4 \cdot Rating_{Highway\ PM} + 0.6 \cdot Rating_{Highway\ worst\ case})
 \end{aligned} \quad (2)$$

The weighting factors represent the driving frequencies in the different areas:

70% := urban + extra urban

30% := highway

The weighting factors for PM and worst case of the other pollutants are different for NEDC and the Highway cycle. The reason is that the impact of particles on persons is more direct in the city than on the highway, while especially NO_x emissions have shown their negative impact independently. For the emission value of each pollutant (CO, HC, NO_x, PM) the ratings are calculated according to the thresholds given in **Table 2**.

Out of these results for CO, HC and NO_x the worst rating is taken into account for further calculations ("worst case"). In addition a rating for PM is calculated separately. The weight of PM and worst case rating are balanced as shown in Figure 5.

As an example the rating system for NEDC emissions of HC is given in **Figure 6**.

3.2 Carbon Dioxide CO₂

The rating of CO₂ is calculated by contributions of the NEDC cold, NEDC hot and ADAC highway results. The scheme is shown in **Figure 7**.

The rating of the CO₂ emission is calculated according to formula (3) using the thresholds for 10 and 50 points given in **Table 3**. The rating is based on seven vehicle classes with different thresholds each.

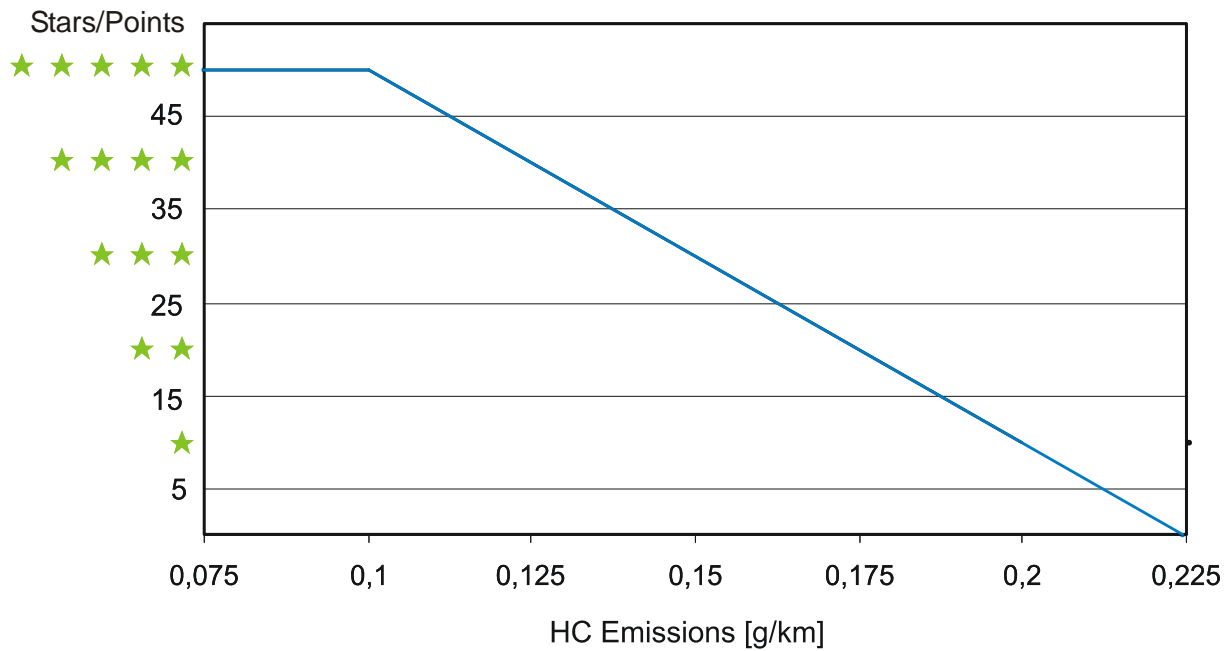


Figure 6: Rating system shown for HC emissions during NEDC driving

$$Rating_{CO_2} = 0.7 \cdot (0.5 \cdot Rating_{NEDC\ cold} + 0.5 \cdot Rating_{NEDC\ hot}) + 0.3 \cdot Rating_{Highway} \quad (3)$$

The thresholds include the potential of future engine developments. As a result the system will remain relevant for a long time period, enabling the test programme to show any technical progress.

The score is calculated with the linear scale defined by the thresholds. While the lowest score is 0 points the scoring system is not restricted to a maximum value, more than 50 points can be achieved.

Figure 8 shows the rating system for the given thresholds of CO₂ emissions.

Table 2: Thresholds for pollutants during NEDC and highway cycle

	NEDC		Highway	
	★★★★★ 50 points at [g/km]	★ 10 points at [g/km]	★★★★★ 50 points at [g/km]	★ 10 points at [g/km]
HC	0.10 ^a	0.20 ^c	0.10 ^a	0.20 ^c
CO	1.00 ^a	2.30 ^c	1.00 ^a	14.00 ^d
NO _x	0.08 ^a	0.50 ^b	0.08 ^a	1.00 ^d
PM	0.005 ^d	0.05 ^b	0.005 ^d	0.05 ^b

- ^{a)} value according to directive 98/69/EC: Euro 4 Petrol NEDC
- ^{b)} value according to directive 98/69/EC: Euro 3 Diesel NEDC
- ^{c)} value according to directive 98/69/EC: Euro 3 Petrol NEDC
- ^{d)} value according to state of the art

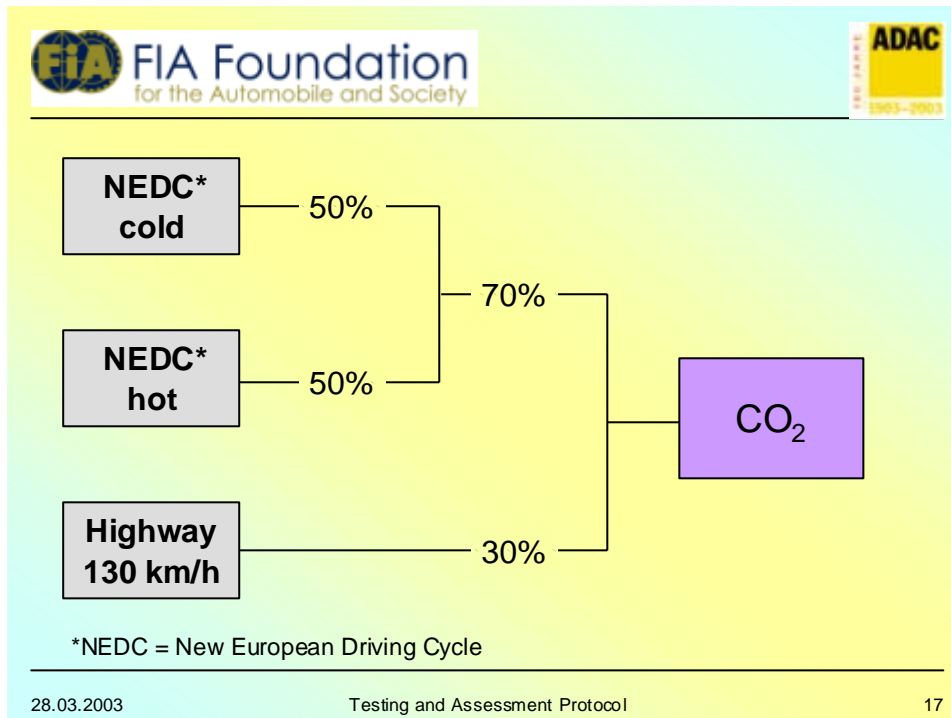


Figure 7: Scheme for the calculation of CO₂ rating

The consumer have a direct comparing of competitors. This is one advantage of the class depending thresholds of CO₂ emissions. An other advantage is the better differentiation within one vehicle class.

3.3 Fuel Consumption

The fuel consumption is calculated for the measured cycles in litres per 100 km. The NEDC is split up into urban and extra urban part. For each part the fuel consumption is determined separately. Furthermore for the highway cycle the fuel consumption is also calculated.

Table 3: Thresholds for CO₂ emission rating

Vehicle class	★★★★★ 50 points at [g/km]	★ 10 points at [g/km]
1	60	150
2	60	150
3	70	175
4	85	205
5	105	240
6	130	280
7	160	325

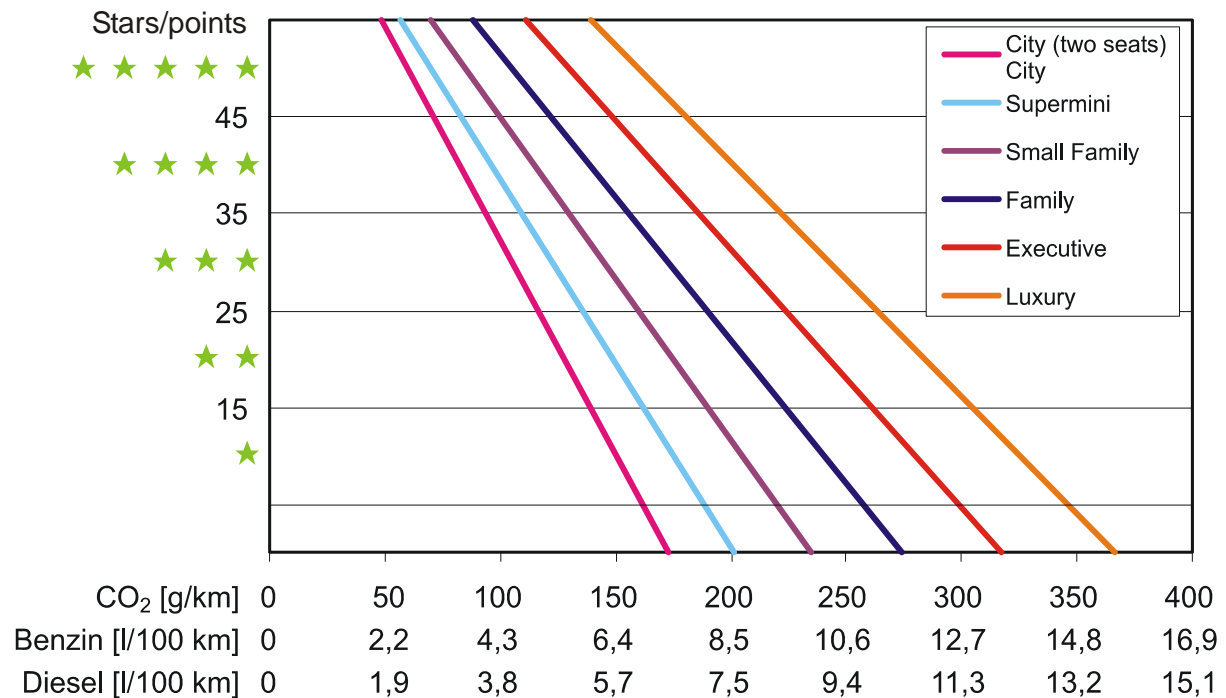


Figure 8: Vehicle class dependant rating system of the CO₂ emissions

The overall value is calculated by 30% ADAC highway driving and 70% NEDC driving, while NEDC includes hot and cold by 50% each. The fuel consumption is not included in the assessment but given as a consumer relevant information.

4 Summary

The EcoTest is intended to enable the assessment of the environmental impact of new cars based on the measurement of pollutants and CO₂ emissions. Beside the homologation cycle NEDC a highway cycle and the influence of air conditioning have been introduced to the test protocol.

The assessment is based on the principle of having the same scales for the different drives. The worst result of CO, HC and NO_x scoring and the score of PM define the Pollution Rating. The thresholds are independent of the vehicle class.

The CO₂ emissions are assessed by separate thresholds for each of the seven defined vehicle classes. The thresholds of CO₂ emissions are class depending because the consumer have a direct comparing of competitors. Also the better differentiation within one vehicle class is a big advantage.

The EcoTest Rating is calculated by the sum of Pollution Rating and CO₂ Rating.