

**TOPTEN – environmental rating system for cars****1 Introduction**

For the environmental rating of passenger cars Topten uses a system which has been developed by the institute for research in energy and environment in Heidelberg (Institut für Energie- und Umweltforschung, IFEU). It was requested in 1997 by the traffic associations (Verkehrsclubs) of Germany, Austria and Switzerland (VCD, VCÖ and VCS) and by the ministry of environment (Umweltbundesamt) of Berlin. It was developed based on recent scientific findings and has been updated several times.

In 2002, a highly regarded study was published by Mark Z. Jacobson, Professor of Stanford University, in which he showed that promoting diesel cars in favour of gasoline cars probably encourages global warming instead of slowing it down. Although diesel cars obtain 25 to 35 percent better mileage and emit less carbon dioxide than similar gasoline cars, they can emit 25 to 400 times more mass of particulate black carbon and associated organic matter ('soot') per kilometer [mile]. According to Mark Z. Jacobson, the warming due to soot may more than offset the cooling due to reduced carbon dioxide emissions over several decades (Jacobson, 2002).

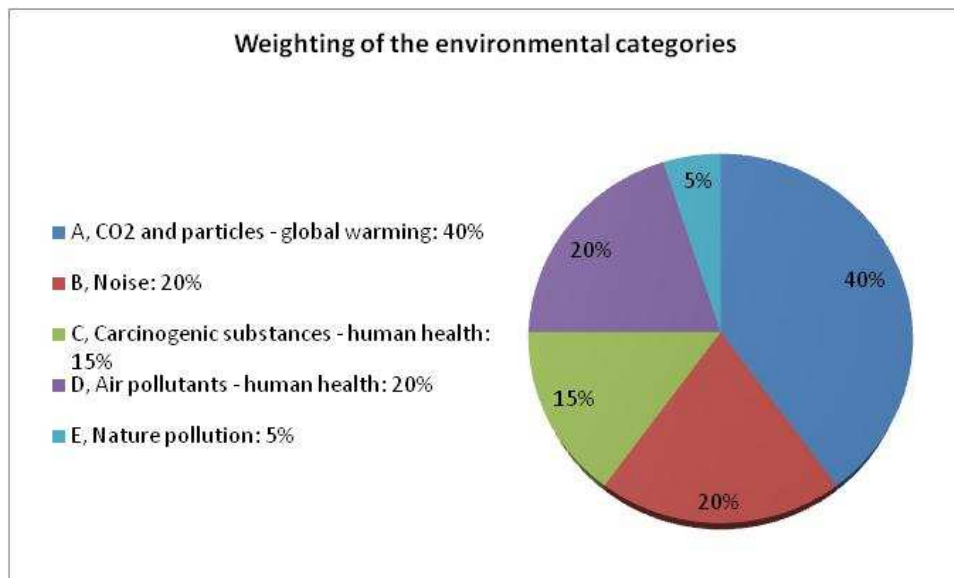
In coordination with the Laboratory of Atmospheric Chemistry of the Paul Scherrer Institute (PSI), factors for the conversion of black-carbon-aerosols emissions into CO<sub>2</sub>-equivalents were dedicated, which allow to integrate the contribution of the particles to global warming into the rating system. The factor chosen by experts (rather conservative 200) adds the equivalent of 18.35 g CO<sub>2</sub>/km to the Ecorating result of Euro-4 models without diesel particulate filter. As a consequence, the Ecorating result of diesel cars without particulate filter is too low to meet Topten's environmental requirements, and no such models make it into the Topten lists.

Chapter 2 shows the Ecorating calculations as well as their derivation.

Detail explanations of calculations and weightings of the version by IFEU from 1997 can be found in Chapter 3 in the German version on [www.topten.ch](http://www.topten.ch), as well as an overview on the adjustments taken since 1997 (Chapter 4 German version).

**2. Topten's Environmental rating system**

Topten's environmental rating system allows to rate polluting effects of new cars comprehensively. The rating is based on comparable data on Carbon dioxide, air pollutant and noise emissions, which is available for all cars. Pollutants are allocated to categories of similar effects on environment and human health, as for instance carcinogenic carbon sooty particles and benzol are summarized in the category 'Carcinogenic Substances'. In order to obtain the total result, Topten assesses and weights the five environmental categories A to E (see graph).



## 2.1 The five categories of environmental effects

### Category A: CO<sub>2</sub> und black carbon particles – global warming

The pre-industrial proportion of Carbon dioxide CO<sub>2</sub> in the air has been increased by roughly 20% due to human emissions, and is still increasing. The result is the global climate warming, with unpredictable, immense consequences. The transport sector is the most important CO<sub>2</sub> emittant: in Switzerland it is responsible for about one third of the total CO<sub>2</sub> emissions, and emissions are still on the rise. CO<sub>2</sub> emissions of cars depend on their fuel consumption. Cars with diesel motors commonly emit less CO<sub>2</sub> than petrol driven cars. In the case of diesel models without particulate filter however, this advantage is offset by the climate harming effect of the soot particle emissions.

### Category B: noise emissions

Two thirds of Switzerland's population feel discommoded by noise imissions, mostly traffic noise. Road traffic is responsible for three quarters of all traffic noise. A considerable part of the population is burdened by noise levels higher than the lawful limits. Chronic exposure to noise provokes stress reactions and can affect health.

### Category C: Carcinogenic Substances

Diesel sooty particles and benzol from petrol motors are carcinogenic – meaning they can provoke cancer. The risk of cancer by sooty particles is eight times higher than the one by benzol in agglomerations, and ten times higher in rural areas. Therefore, emissions of sooty particles and benzol are weighted in the ratio of 9:1.

### Category D: air pollutants (NO<sub>x</sub>, HC und particles)

Despite the catalysers, cars emit lots of nitrogen oxides (NO<sub>x</sub>) and hydrocarbons (HC). These pollutants influence human health in several ways, such as promoting respiratory diseases and allergies. Apart from their health impact these substances have an important role in the formation of ozone ('summer smog'). Since as a part of particulate matter they also impair lung function, particles are listed again in this category. They can cause respiratory problems and infectious diseases such as acute bronchitis or chronic cough.

### Category E: Nature pollution

The main substances responsible for nature pollution are nitrogen oxides (NO<sub>x</sub>). Nitrogen oxides as well as sulfur dioxides cause overfertilization of soils and aquatic systems.

**2.2 Calculation of the EcoRating**

The emissions in the five categories of environmental effects are being measured in different units (g/km, dB(A)), but have to be normalised in order to be comparable. This is done by a score system which rewards a better car with a higher score.

At first, cars are rated for every single of the five categories of environmental effects, on a scale of 0 to 10 (with 10 being the best value). The rating is based on current environmental objectives..

**Category A: CO<sub>2</sub> und black carbon particles – global warming**

A car’s CO<sub>2</sub>-emissions are rated here with a linear function. For CO<sub>2</sub>-emissions of 80 grams per kilometer (corresponding to a consumption 3.4 liters of gasoline or 3 liters of diesel per 100 km) 10 points are granted, while 210 grams of CO<sub>2</sub> per kilometer score 0 points. Vans that emit more than 210 grams get negative points in this category. The precise formula is: Eco Rating points = 10 – (x-80 g/km)\*0.077 , x = CO<sub>2</sub>-emissions in g/km

**Category B: noise emissions**

The rating is based on a model’s indications of the type test. The scale runs linearly between 10 points for 65 dB(A) and 0 points for 75 dB(A) and more.

**Categories C to E**

These categories are all rated according to the same scheme. A car’s score in these categories is defined by its emission class (Euro 3, Euro 4 or Euro 5). Euro 4-diesel cars with a particulate filter get higher scores, because they have no particulate emissions (see tables).

| Rating of emission classes |                            |  |                     |
|----------------------------|----------------------------|--|---------------------|
| emission class             | C: carcinogenic substances | D: air pollutants (NOx, HC, particles) | E: nature pollution |
| Euro 3 diesel              | 0.00                       | 1.88                                   | 0.00                |
| Euro 3 diesel with PF      | 10.00                      | 7.58                                   | 0.00                |
| Euro 3 gazoline            | 9.83                       | 7.67                                   | 8.33                |
| Euro 4 diesel              | 5.07                       | 6.19                                   | 5.95                |
| Euro 4 diesel with PF      | 10.00                      | 8.89                                   | 5.95                |
| Euro 4 gazoline            | 9.99                       | 9.18                                   | 10.00               |
| Euro 4 diesel DeNOx-Cat PF | 10.00                      | 9.04                                   | 7.98                |

PF = particulate filter

**Emission limits for passenger cars**

| Emission standard | valid from | CO (g/km) | HC (g/km) | NOx (g/km) | HC+NOx (g/km) | particles (g/km) |
|-------------------|------------|-----------|-----------|------------|---------------|------------------|
| <b>Gazoline</b>   |            |           |           |            |               |                  |
| Euro 2            | 01.10.1996 | 2.20      | -         | -          | 0.50          | -                |
| Euro 3            | 01.01.2001 | 2.30      | 0.20      | 0.15       | -             | -                |
| Euro 4            | 01.10.2006 | 1.00      | 0.10      | 0.08       | -             | -                |
| Euro 5            | 01.07.1905 | 1.00      | 0.075     | 0.06       | -             | 0.005            |
| Euro 6            | 06.07.1905 | 1.00      | -         | 0.06       | -             | 0.005            |
| <b>Diesel</b>     |            |           |           |            |               |                  |
| Euro 2            | 01.10.1996 | 1.00      | -         | -          | 0.70/0.90*    | 0.08/0.10*       |
| Euro 3            | 01.01.2001 | 0.64      | -         | 0.50       | 0.56          | 0.050            |
| Euro 4            | 01.10.2006 | 0.50      | -         | 0.25       | 0.30          | 0.025            |
| Euro 5            | 01.07.1905 | 0.50      | -         | 0.180      | 0.23          | 0.005            |
| Euro 6            | 06.07.1905 | 0.50      | -         | 0.08       | 0.17          | 0.005            |

CO= carbon monoxide

NOx=nitrogen oxides

HC= hydrocarbons

\* = with direct fuel injection

Source: BUWAL

**ECO-Score**

For a car's total score (ECO-score) the scores of the single environmental effect categories are weighted and added up:

$$\text{ECO-score} = \text{score}(\text{cat.A}) \cdot 0.4 + \text{score}(\text{cat.B}) \cdot 0.2 + \text{score}(\text{cat.C}) \cdot 0.15 + \text{score}(\text{cat.D}) \cdot 0.2 + \text{score}(\text{cat.E}) \cdot 0.05$$

To increase the result's readability, it is multiplied by the factor 10, and displayed graphically (in ECO-Stars). The resulting total score has to be interpreted the following way: the higher a car's score, the smaller its environmental impact.

The minimum score necessary for Topten can be found in Topten's Selection criteria ([www.topten.info](http://www.topten.info) > Cars > Selection criteria).