

Parameter: Regulated Pollutants (*Weightage: 30 %*)

Existing and promising approaches worldwide for measuring Regulated Pollutants and CO₂ for determining Environment Friendliness of Vehicles are given below:

1. ECO-TEST ADAC / FIA

This approach was put forward by German Automobile Club ADAC. Eco-Test is based on driving cycle measurements on chassis dynamometers. Tests are carried out on NEDC Cold Test, NEDC Hot Test and on the ADAC Highway Driving Cycle (the latter test cycles are performed with the air conditioning switched on)

Rating was given as follows:

CO₂ Emissions: 50% in overall rating

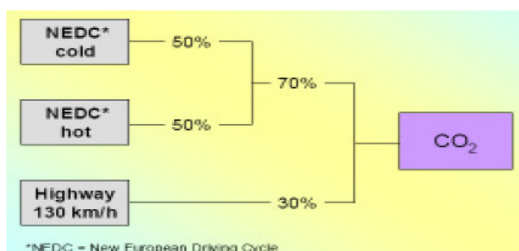
Regulated Pollutants: 50% in overall rating

The rating of the CO₂-emissions rests upon relative scales on account of different vehicle classes. Rating the vehicles on an absolute scale would merely indicate that large cars will have higher emissions than smaller ones.

ID	Vehicle class	Example
1	City (two seats)	Smart
2	City	Fiat , Peugeot 105, 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

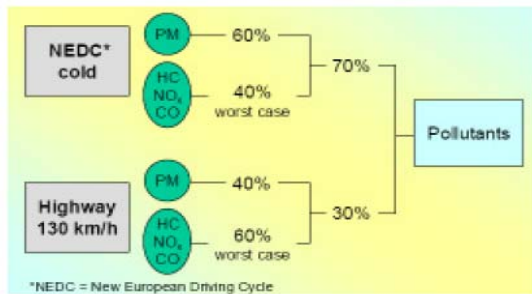
Testing:

The rating of CO₂ is due to the contribution of the NEDC Cold, NEDC Hot and ADAC Highway results with different weighting factors for the involved cycles and based on seven vehicle classes each with different thresholds.



Vehicle class	★★★★★ 50 points at [g/km]	★ 10 points at [g/km]
1	60	150
2	60	150
3	70	176
4	85	205
5	105	240
6	130	280
7	160	325

In contrast to the class depending CO₂-rating the assessment of the limited pollutants (CO, HC, NO_x and PM) is independent of vehicle classes. Unlike in the emission legislation the same criteria and emission levels are applied to gasoline, diesel, natural gas and hybrid power trains.



	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

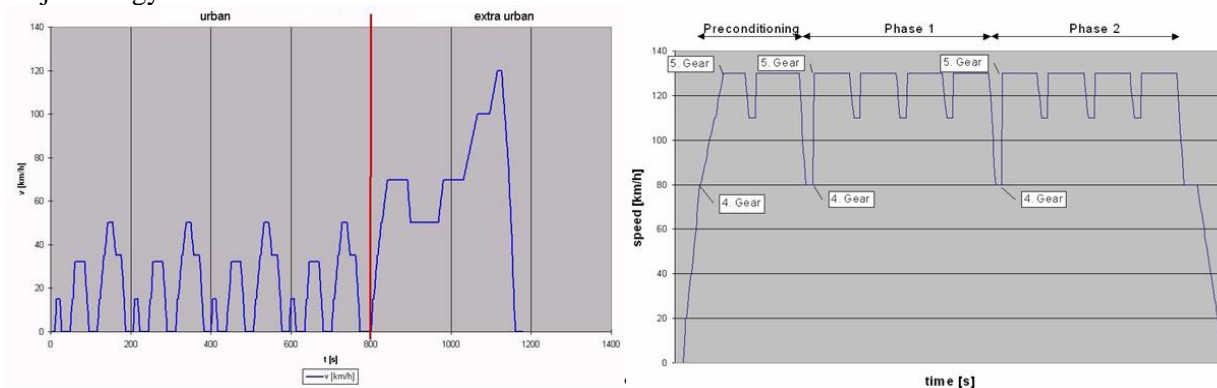
^c) value according to directive 98/69/EC: Euro 3 Petrol NEDC

^d) value according to state of the art

The rating is calculated on the basis of the performance in the NEDC cold and ADAC highway cycle. The worst results in each cycle define the pollution rating. For all cars – regardless of whether petrol or diesel engines, with or without direct injection system – the same rating formula is applied. Although conventional petrol engines have no particle emissions detectable by gravimetric measurement no problem emerges with this formula. As a direct consequence of the formula conventional petrol vehicles will result in the maximum score for particles.

The Cycle for the CO₂ is ADAC Highway driving cycle with Air Condition ON during the test.

The New European Driving Cycle (NEDC): The first segment in the NEDC represents an urban cycle with stop-and-go; the second segment represents an extra-urban cycle at up to 120kph. Each vehicle is measured from a cold-crank with all energy-consuming devices, such as radio or air condition, turned off. Then the NEDC is run again with a warm engine and the air condition on to take into accounts one of the major energy users in a vehicle.



The ADAC Motorway Cycle: The ADAC Motorway Cycle shows whether the exhaust cleaning system operates optimally outside the parameters of the statutory tests. We look at the emissions generated when the engine is accelerated more forcefully or at full throttle with the air condition on. This cycle uses a base speed of 130kph, which is the speed limit in most European countries. In India, it can be lowered down to 90 kmph.

The final CO₂ Value is compared against the values in the table to determine the CO₂ Score of the Vehicle.

2. VCD

This approach is designed for consumer information to know the best cars in the market. The rating is given from 0 to 10 points in each case, but the four distinct categories have different shares of the overall appraisal.

The four categories affect:

- 1. CO₂-emissions** (with 10 points relating to 60 g/km and 0 points to 180 g/km; share of the overall rating: **60 per cent**)
- 2. Noise** (with 10 points relating to 65 dB (A) and 0 points to 75 dB (A); share of the overall rating: **20 per cent**)
- 3. Human burden** from pollutants (NO_x, NO₂, PM); share of the overall rating: **15 per cent**
- 4. Impact on the nature**; share of the overall rating: **5 per cent**

The 3, 4 categories totally depend on Euro 4, Euro 5, and Euro 6 emission stages.

	Euro 4		Euro 5		Euro 6*
	Otto	Diesel	Otto	Diesel	Diesel
Gesundheit – NO _x	6,8	0,0	7,6	2,8	6,8
Gesundheit – NO ₂	9,7	0,0	9,8	2,8	6,8
Gesundheit – Partikel	10,0	10,0	10,0	10,0	10,0
Gesamtwert für Gesundheit	9,13	5,0	9,35	6,4	8,4
Natur – NO _x	6,8	0,0	7,6	2,8	6,8
Umgerechnet in Gesamtpunkte	1,7	0,8	1,8	1,1	1,6

* Bei der Grenzwertstufe Euro 6 bleiben die Werte für den Otto-Pkw auf dem Niveau von Euro 5

With regard to the category ‘human burden from pollutants’ it has to be mentioned that within this topic the three pollutants NO_x, NO₂ and PM have different weighting factors (NO_x: 25 per cent, NO₂: 25 per cent and PM: 50 per cent).

The applied data were taken from information from vehicle manufacturers.

3. ÖKO-TREND INSTITUTE

Öko-TREND institute awards an environmental certificate for cars.

Rating was given as follows:

- The evaluation of the vehicle (operation and equipment): 55 per cent of the overall rating
- Vehicle making and recycling of the vehicle: 45 per cent of the overall rating.

The several evaluation categories are:

- operation / use of vehicle (contributes with **50per cent** to the overall rating)
Criteria are e.g.: fuel consumption, CO₂-emission, pollutant emissions, noise emission
- equipment of the car (contributes with **5per cent** to the overall rating)
Criteria are e.g.: fuel consumption indicator, stop-start automatic device
- logistics (contributes with **5per cent** to the overall rating)
Criteria are e.g.: transport of new cars by ship or train

- make of vehicle (contributes with **17per cent** to the overall rating)
Criteria are e.g.: expenditure of energy for producing the car, avoidance of usage of Environmentally hazardous substances and manufacturing processes, waste prevention, kind of painting
- recycling (contributes with **9per cent** to the overall rating)
Criteria are e.g.: usage of recycled materials in new cars, usage of renewable raw materials in new cars
- environmental management / eco-audit (contributes with **14per cent** to the overall rating)
Criteria are e.g.: manufacturer's perception of ecological and social responsibility, offer of eco-trainings.

A certificate will be awarded, if the total scoring results in more than **90 per cent** of the overall points.

4. ENVIRONMENTAL PERFORMANCE LABEL FROM CARB

Rating is based on the sum of vehicle's greenhouse gas emissions which are identified as the CO₂-equivalent value. The measured emissions include Carbon Dioxide (CO₂), Methane (CH₄), Nitrous Oxide (N₂O) and emissions related to the use of air conditioning. The global warming score ranks each vehicle's CO₂-equivalent value on a **scale of 1 - 10 (10 being the cleanest)** relative to all other vehicles within the current model year. The scores are also properly adjusted to reflect the contribution of greenhouse gas emissions from the production and distribution of the fuel type used.

CO₂-equivalent levels:

Global Warming Score	CO ₂ -equivalent Grams per mile
10	Less than 200
9	200 – 239
8	240 – 279
7	280 – 319
6	320 – 359
5	360 – 399
4	400 – 439
3	440 – 479
2	480 – 519
1	520 and up

Smog Score	NMOG + NO _x Gram per mile**
10	0,000
9*	0,030
8	0,030
7	0,085
6	0,110
5	0,125
4	0,160
3	0,190
2	0,200
1	> 0,356

Smog Score and pollutant levels of non-methane organic gases (NMOG) and oxides of nitrogen (NO_x).

*A smog score of 9 was given to vehicles certifying to the California PZEV and ATPZEV standards based on the longer useful life, zero evaporative emissions requirements, and extended warranty for these vehicles compared to vehicles certifying the SULEV standards.



















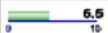
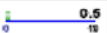
** Does not include upstream emissions nitrogen (NO_x) relative to all other vehicles within the current model year. Again the scores will be on a scale from 1 – 10 with 10 being the cleanest. And again the average vehicle available in California today will get a smog score of 5.

These scores compare emissions between all vehicle classes and sizes with the average new car scoring 5 on both scales.

5. GREEN VEHICLE GUIDE FROM THE AUSTRALIAN GOVERNMENT

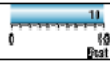


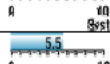


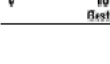
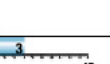
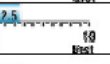
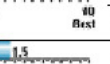
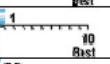
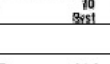
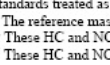
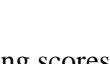




Rating is based on two parameters:

- Greenhouse Rating (weighting 50 per cent)
 - Air Pollution Rating (weighting 50 per cent)
- 1) Greenhouse ratings based on CO₂ Emissions.

Greenhouse Rating	CO ₂ Emissions (combined g/km)	Greenhouse Rating	CO ₂ Emissions (combined g/km)
 10	<= 60	 5	241 - 260
 9.5	61 - 80	 4.5	261 - 280
 9	81 - 100	 4	281 - 300
 8.5	101 - 120	 3.5	301 - 320
 8	121 - 140	 3	321 - 340
 7.5	141 - 160	 2.5	341 - 360
 7	161 - 180	 2	361 - 380
 6.5	181 - 200	 1.5	381 - 400
 6	201 - 220	 1	401 - 420
 5.5	221 - 240	 0.5	421 - 440

2) Air pollution ratings:

Stage 2 Air Pollution Ratings (applicable from 1 January 2006)

Air Pollution Rating	Fuel Type	Vehicle Type ⁱ RM = reference mass ⁱⁱ (kg)	ADR compliance	Additional GVG emissions requirements	Equivalent Euro Standard	Emissions Limits (g/km)		
						HC	NOx	PM
	Electric	All	All	-	-	-	-	-
	Petrol, LPG, NG	All	ADR79/02	Euro 4 certification and HC ≤ 0.035g/km and NOx ≤ 0.028g/km ⁱⁱⁱ	Beyond Euro 4	0.035	0.028	-
	Diesel	All	ADR79/01	HC ≤ 0.035g/km and NOx ≤ 0.028g/km and PM ≤ 0.00875g/km ^{iv}	Beyond Euro 4	0.035	0.028	0.00875
	Petrol, LPG, NG	Passenger Goods carrying (RM ≤ 1305)	ADR79/02	Euro 4 certification	Euro 4	0.10	0.08	-
	Petrol, LPG, NG	Goods carrying (1305 < RM ≤ 1760)	ADR79/02	Euro 4 certification	Euro 4	0.13	0.10	-
	Petrol, LPG, NG	Goods carrying (RM > 1760)	ADR79/02	Euro 4 certification	Euro 4	0.16	0.11	-
	Petrol, LPG, NG	Passenger Goods carrying (RM ≤ 1305)	ADR79/01	-	Euro 3	0.20	0.15	-
	Diesel	Passenger Goods carrying (RM ≤ 1305)	ADR79/01	-	Euro 4	{ HC + NOx ≤ 0.25 } { HC + NOx ≤ 0.30 }		0.025
	Petrol	Goods carrying (1305 < RM ≤ 1760)	ADR79/01	-	Euro 3	0.25	0.18	-
	Petrol, LPG, NG	Goods carrying (RM > 1760)	ADR79/01	-	Euro 3	0.29	0.21	-
	Diesel	Goods carrying (1305 < RM ≤ 1760)	ADR79/01	-	Euro 4	{ HC + NOx ≤ 0.33 } { HC + NOx ≤ 0.39 }		0.04
	Diesel	Goods carrying (RM > 1760)	ADR79/01	-	Euro 4	{ HC + NOx ≤ 0.39 } { HC + NOx ≤ 0.46 }		0.06
	Diesel	Passenger Goods carrying (RM ≤ 1305)	ADR79/00	Euro 3 certification	Euro 3	{ HC + NOx ≤ 0.50 } { HC + NOx ≤ 0.56 }		0.05
	Diesel	Goods carrying (1305 < RM ≤ 1760)	ADR79/00	Euro 3 certification	Euro 3	{ HC + NOx ≤ 0.65 } { HC + NOx ≤ 0.72 }		0.07
	Diesel	Passenger Goods carrying (RM ≤ 1250)	ADR79/00	-	Euro 2	{ HC + NOx ≤ 0.70 } { HC + NOx ≤ 0.86 }		0.08
	Diesel	Goods carrying (RM > 1760)	ADR79/00	Euro 3 certification	Euro 3	{ HC + NOx ≤ 0.78 } { HC + NOx ≤ 0.86 }		0.10
	Diesel	Goods carrying (1250 < RM ≤ 1700)	ADR79/00	-	Euro 2	{ HC + NOx ≤ 1.00 } { HC + NOx ≤ 1.20 }		0.12
	Diesel	Goods vehicles (RM > 1700)	ADR79/00	-	Euro 2	{ HC + NOx ≤ 1.20 } { HC + NOx ≤ 1.20 }		0.17

ⁱ Passenger vehicles with a maximum mass greater than 2500kg and, in the case of ADR79/00, vehicles with greater than 6 seats are, for the purposes of the emissions standards treated as goods carrying vehicles. The maximum mass of a vehicle refers to the maximum laden mass that is technically possible for that vehicle.

ⁱⁱ The reference mass of a vehicle refers to the unladen vehicle mass plus 100kg.

ⁱⁱⁱ These HC and NOx values represent 35% of the Euro 4 limits for a standard petrol passenger car.

^{iv} These HC and NOx limits are these same as per (iii) above and the PM value is equivalent to 35% of the Euro 4 limit for a standard diesel passenger car.

Combining scores of CO₂ emissions and regulated pollutants, final score is obtained.

Overall Rating	Combined Air Pollution & Greenhouse Score
★★★★★	combined score ≥ 16
★★★★☆	15 ≤ combined score < 16
★★★★	14 ≤ combined score < 15
★★★☆☆	11.5 ≤ combined score < 14
★★★★	9.5 ≤ combined score < 11.5
★★★☆☆	8 ≤ combined score < 9.5
★★☆☆*	6.5 ≤ combined score < 8
★☆☆*	5 ≤ combined score < 6.5
★☆☆	combined score < 5

6. GREEN VEHICLE GUIDE FROM US EPA

The Environmental Protection Agency (EPA) also publishes a "Green Vehicle Guide". The Guide is designed for cars and trucks and provides the user with information about:

- **Air Pollution**

A score from 0 to 10 reflects vehicle tailpipe emissions based on US and California emission standards:

Air Pollution Score MY 2008 & Earlier			Air Pollution Score MY 2009+		
Score	US EPA Tier 2 Emission Standard	California Air Resources Board LEV II Emission Standard	Score	US EPA Tier 2 Emission Standard	California Air Resources Board LEV II Emission Standard
10	Bin 1	ZEV	10	Bin 1	ZEV
9	Bin 2	SULEV II	9	Bin 2	SULEV II
8	Bin 3	--	8	Bin 3	--
7	Bin 4	ULEV II	7	Bin 4	ULEV II
6	Bin 5	LEV II	6	Bin 5	LEV II
5	Bin 6	LEV II option 1	5	Bin 6	LEV II option 1
4	Bin 7	--	4	Bin 7	--
3	Bin 8	SULEV II lg trucks	3	Bin 8	SULEV II lg trucks
2	Bin 9	ULEV II lg trucks	2	--	ULEV II lg trucks
1	Bin 10	LEV II lg trucks	1	--	LEV II lg trucks
0	Bin 11	--	0	--	--

* Bin 9, 10, 11 phased out in MY 2009

- **Fuel Economy**

Starting in model year 2008, EPA tests vehicles by running them under real world conditions. Effects of faster speed and acceleration, air conditioner use and colder outside temperatures are considered in additional driving cycles.

City: Represents urban driving, in which a vehicle is started with the engine cold and driven in stop-and-go rush hour traffic.

Highway: Represents a mixture of rural and interstate highway driving with a warmed-up engine, typical of longer trips in free-flowing traffic.

High Speed: Represents city and highway driving at higher speeds with more aggressive acceleration and braking.

Air Conditioning: Account for air conditioning use under hot outside conditions (95°F sun load).

Cold Temperature: Tests the effects of colder outside temperatures on coldstart driving in stop-and-go traffic.

- Greenhouse gases

The approach reflects the estimates, considering all steps in use of a fuel, from production and refining to distribution and final use; vehicle manufacture is excluded.

The chart shows the minimum fuel economy (combined city, highway fuel economy) for each fuel type at each Greenhouse Gas Score. The **miles per gallon** vary by fuel type because each fuel has different carbon content per gallon. This means each fuel creates different levels of CO₂ emissions per gallon. The overall GHG-scoring relates to the WTW emissions.

A score from 0 to 10 reflects the amount of CO₂, N₂O and CH₄ emissions.

Greenhouse Gas Score Criteria MY 2008 & Earlier						
GHG Score	Pounds CO ₂ e per mile	Minimum Label MPG (combined)				
		Gasoline	Diesel	E85	LPG	CNG*
10	Less than 0.62	37	43	23	23	31
9	0.62 to <0.76	31	36	19	19	26
8	0.76 to <0.90	26	30	16	16	22
7	0.90 to <1.06	23	26	14	14	19
6	1.06 to <1.16	20	23	12	12	17
5	1.16 to <1.28	18	21	11	11	15
4	1.28 to <1.43	16	19	10	10	14
3	1.43 to <1.52	15	17	9	9	13
2	1.52 to <1.62	14	16	8	8	12
1	1.62 to <1.73	13	15	7	7	11
0	1.73 and up	1	1	1	1	1

Greenhouse Gas Score Criteria MY 2009+						
GHG Score	Pounds CO ₂ e per mile	Minimum Label MPG (combined)				
		Gasoline	Diesel	E85	LPG	CNG*
10	Less than 0.61	39	45	24	24	33
9	0.61 to <0.74	33	38	20	20	27
8	0.74 to <0.87	28	32	17	17	23
7	0.87 to <1	24	28	15	15	20
6	1 to <1.13	22	25	13	13	18
5	1.13 to <1.25	19	22	12	12	16
4	1.25 to <1.38	18	20	11	11	15
3	1.38 to <1.51	16	19	10	10	14
2	1.51 to <1.63	15	17	9	9	12
1	1.63 to <1.76	14	16	8	8	12
0	1.76 and up	1	1	1	1	1

Vehicles, which rate 6 or better on each of the both scores (air pollution and GHG) and have a combined score of at least 13 are labeled with the **SmartWay** designation and vehicles, which rate 9 or better on each of the both scores are labeled with the **SmartWay Elite** designation.

The scores can be used to compare all vehicles and all model years against one another. The best environmental performers receive the SmartWay labels, which mean the vehicles scores well on both Air Pollution and Greenhouse Gas.

The suggested Approach:

This environmentally friendly vehicle rating will be applicable only for M1 category.

At the first step of application of EFV concept, Type Approval Test values should only be considered.

The Regulated pollutants play an important role in determining the extent of environment friendliness of vehicle. Studies reveal that the automobile accounts for 50% of the Hydrocarbons, over 75% of Carbon Monoxide and nearly 50% of oxides of nitrogen that pollute the atmosphere. A significant amount of Hydrocarbon comes from the fuel tank and crankcase, but the exhaust gases are the major source of pollutants. This is the biggest challenge automobile industry is facing today, followed by need to minimize the fuel consumption and thereby carbon dioxide. If the combustion and oxidation were complete in engine, water and carbon dioxide would be the only byproducts of the combustion of fuel. But this is practically impossible. So the regulations are tightened periodically for the manufacturers to develop better technology. Rating Protocol of regulated pollutants for EFV is given below.

The overall weightage considering environmental friendliness of the vehicle should be given 30 % to Regulated pollutants, i.e. the maximum score one vehicle can attain will be 30%. The limits that are considered here are based on the vehicle reference mass and are equivalent to Euro-IV, Euro-V and Euro-VI limits. The driving cycle and test procedure shall be in line with European regulation and the results to be compared with the values in the table given below to calculate the emission score. The following parameters are considered while calculating the emission score of vehicle.

- 1) Emission Test results of Vehicle: for Co, HC, NO_x and PM
 - 2) Idling Co for SI Engines
 - 3) Evaporative Emissions for SI Engines
 - 4) Free Acceleration Smoke for CI Engines
 - 5) Full load Smoke for CI Engines
- Max. Score for electric vehicle is 30
 - Max. score for other than electric vehicle (petrol, diesel, CNG, LPG) is 30, including mass emission test Score, idling CO emissions score & evaporative emissions score. Similarly, for diesel max. Score will be 30. Including mass emission test score, full load smoke score and free acceleration smoke score. The values should be taken from Type Approval Test.

Sr. No.	Fuel Type	Vehicle Type wrt Reference Mass	Emission standard For CO, HC, NO _x , PM , PN SI Engine: Idling CO+ Evaporative Emissions CI Engine: Full load + Free Acceleration Smoke		
			Euro-IV	Euro-V	Euro-VI
1	Electric / Hydrogen	All	30		
2	Petrol / Blends of Petrol , LPG, CNG	$RM \leq 1305$	14	22	30
3	Petrol / Blends of Petrol, LPG, CNG	$1305 < RM \leq 1760$	12	18	25
4	Diesel /Biodiesel/Blends	$RM \leq 1305$	14	22	30
5	Diesel /Biodiesel/Blends	$1305 < RM \leq 1760$	12	18	25
6	Petrol / Blends of Petrol, LPG, CNG	$RM > 1760$	10	16	22
7	Diesel /Biodiesel/Blends	$RM > 1760$	10	16	22
