Rating Scheme Description
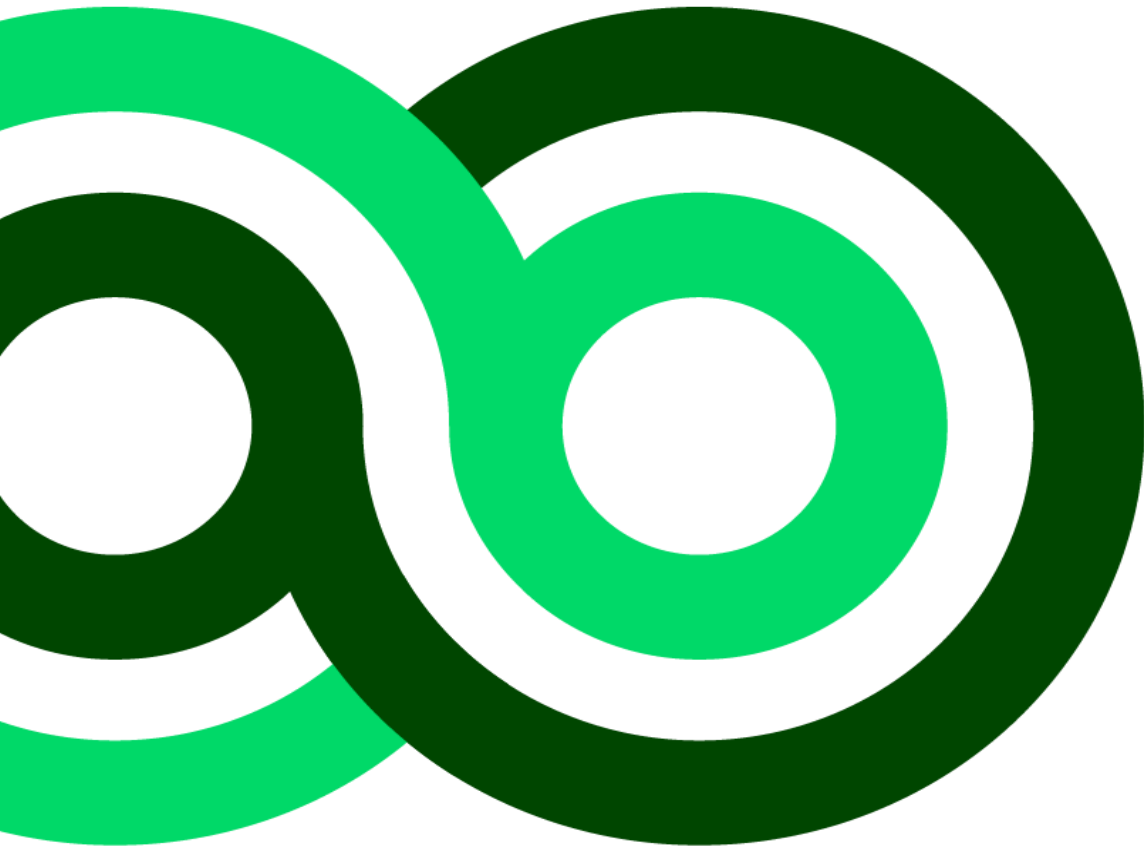
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Green NCAP Rating Scheme

Contents

1. The overall environmental performance rating

1.1 Introduction

In a parallel development to the Green NCAP test program a scheme was developed that funnels test findings into overall ratings. This document describes the scheme and its background.

In NCAP tradition Green NCAP generates 'star ratings[1]' that are easy to understand for consumers, with scores ranging from 0 stars (poor) to 5 stars (best). More detailed information is available in several layers of underlying sub-ratings to accommodate specific target groups like interested consumers, experts and (local) policy makers. The star ratings are built on the pillars 'clean air' and 'efficiency'. Per car tested a datasheet is compiled detailing all steps from measurements to star rating.

Like in Euro NCAP, the rating system[2] is transparent regarding the translation from gathered data into scores and combining scores into an overall rating. These ratings will help consumers and businesses to identify the 'greenest' choice for their needs.

Inspiration was also gathered from ADAC's Ecotest[3] program, a consumer information program on fuel consumption and emissions, in which an overall star rating combines summarising scores for fuel consumption and pollutant emissions. ADAC's rating scheme fits pretty well the Euro NCAP philosophy; therefore, it made sense to build the Green NCAP system along similar lines.

1.2 General principles

Starting point is an Excel datasheet for each car tested – as in the Euro NCAP crash tests. There are two boxes (Clean Air Index, based on Pollutant Emissions and Energy Efficiency Index) and an overall 'star[4]' rating based on scores in the respective boxes. Ratings are independent from vehicle class.
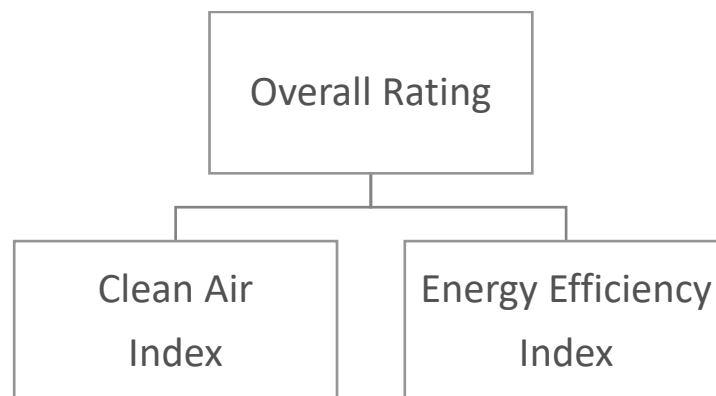

Fig. 1: Main sub division overall rating

The content of the two boxes is specified in the two tabs 'Clean Air' and 'Efficiency' in the standardised spreadsheet and generates the 'Star Rating' out of objective laboratory and real-world measurements. The naming is chosen to be as intuitive and easy-to-understand as possible. For both indexes hold: the higher the value, the better the vehicle's performance. This is also true for the overall rating: the higher the number of "stars" the more favourable is our overall verdict. The term index, expressed as a number between 0 and 10 with one single decimal, is preferred over rating or score in percentage to avoid an incorrect association with engine efficiency.

The Clean Air index aims to contribute to improvement of air quality by stimulating OEM's to reduce harmful emissions and help consumers, among others, to prove that their vehicles are clean enough to be allowed entering urban low emission zones. The energy efficiency rating encourages economical use

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[1] Working title, stars may be replaced by another set of symbols
[2] Euro NCAP Ratings Group report 2015
[3] Ecotest Test- und Bewertungskriterien (as of 12/2016)
[4] Star rating = working title

of scarce energy sources and is moreover interesting for consumers as it influences directly the running costs of a car and reduces energy waste.

Ratings are based on measurements on one car, following the recommendation of ISO/IEC Guide 46[5]: *Every sample is deemed to fall within the quality borders set by the manufacturer. Where there is substantial doubt as to whether the sample is representative or not, a new sample should be procured for comparative testing.*

The rating spreadsheet includes 5 tabs, for each car tested data are fed into the tabs SPECS, Laboratory and PEMS real-world test results. The OVERALL RATING and indexes for Clean Air and Efficiency are generated then and can be found in the respective tabs.

| OVERALL RATING | Clean Air | Efficiency | limits | SPECS | Lab results | PEMS results |

Table 1: Tabs in rating spreadsheet

Results from laboratory test cycles (WLTC-cold/-standard/-eco/-sport and BAB 130) and on-the-road tests (additional dedicated PEMS tests) will be copied into either the Clean Air tab (HC, NOx, CO, PM, PN) or the Efficiency tab (fuel/energy consumption, CO_2 emission).

The overall star rating is determined by the thresholds in Table 2 below. In order to be eligible for a certain star rating, thresholds for both Clean Air and Energy Efficiency must be met.

	Clean Air Index	Energy Efficiency index
For five stars at least	8,0	7,5
For four stars at least	7,0	6,0
For three stars at least	6,0	4,5
For two stars at least	5,0	3,0
For one star at least	4,0	1,5

Table 2: Thresholds for star rating

The test program will be further developed over the years. Items in *italic* are placeholders for the time being. Once implemented in the program points will be allocated. It was decided that in pollutants and energy efficiency each test contributes to the final rating according to table 3. The WLTC 'cold' (at engine start) result is considered of equal importance as the three WLTC 'warm' cycles. In absence of eco/sport modes, the standard setting test values are used instead.

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[5] Comparative testing of consumer products and related services – General principles

Clean Air			Energy efficiency	
Test	Points		Test	Points
WLTC -cold	9		WLTC -cold	10
WLTC -warm (standard)	3		WLTC – warm (standard)	3
WLTC -warm (eco)	3		WLTC -warm (eco)	3
WLTC -warm (sport)	3		WLTC -warm (sport)	3
PEMS+	7		PEMS+	*0*
BAB130	9		BAB130	10
[PEMS robustness]	*0*		*[PEMS robustness]*	
			[Driving Range]	*5*
			[Driving Resistance]	
Total Available	**34**		**Total Available**	**34**

Table 3: Points allocation

1.3 Rating Box 1: Clean Air Index

The Clean Air Index is based on a measurement of pollutants. Test cars are subject to tailpipe emission tests both in the laboratory (WLTC in different conditions, BAB130) and under real-world conditions. In these tests the following emission components are measured: HC, NOx , CO, PM, PN.

Regarding the points distribution, over the different components detrimental 'trade-offs' are discouraged: low scores for important components (e.g. NOx) cannot be compensated by less important ones (e.g. CO).

Reduction of NOx and PN, and to a lesser extent HC, is in the main focus of the pollution tests. To reflect this, the maximum number of points for NOx and PN are set at 3, for HC at 2, PM (considered redundant with PN) at 0 and the remaining component CO on 1. This adds up to the 9 points per test in table 3 and 7 points for PEMS tests as HC is not yet measured with mobile emission test equipment.

The number of points scored per component in each test can only be achieved if the measured value undercuts a certain threshold ('lower threshold'). If the measured value is exceeding another, higher threshold ('upper threshold'), the score for that particular component becomes negative. In case this negative contribution would lead to a negative score for that particular test, the overall result for that test is limited to zero points. Otherwise, in case of gross exceedance of the upper value for a certain component the overall result for that particular test is zero points ('capping'), irrespective of the measured values for other components. The gross exceedance threshold is set at 150% of the upper threshold. Measured values between lower and upper threshold are determined by a sliding scale (through interpolation). All scores are rounded to one decimal.

For each component the upper threshold is the current legal limit for new cars in the EU (Euro 6d). These are currently different for diesel and petrol cars. Moreover, for diesel cars there is a combined limit for NOx and HC (170 mg/km). It was decided to split this combined constituents' limit into separate NOx (80 mg/km) and HC (90 mg/km) thresholds (table 4).

Upper Thresholds (lab tests) (mg/km) (PN unit-less)		Gross Excess Threshold (mg/km) (PN unit-less)
	petrol	diesel	petrol
HC	100	90	150
NOx	60	80	90
CO	1000	500	1500
PM	4,5	4,5	6,75
PN	6,0E+11	6,0E+11	6,0E+12

Table 4: Upper- and Gross Excess Thresholds for petrol and diesel engine cars (lab tests)

The lower thresholds are technology neutral and set for each component at 50% (except particulate number (PN): one order of magnitude instead of 50%) of the lowest of the upper regulatory limits for diesel and petrol (table 5).

Lower Thresholds (lab tests) (mg/km) (PN unit-less)	
Petrol AND diesel	
HC	45
NOx	30
CO	250
PM	2,25
PN	6,0E+10

Table 5: Lower Thresholds for petrol and diesel engine cars (lab tests)

For PEMS+ and PEMS robustness tests the similar concept is followed, but a multiplication factor of 1.5 ('conformity factor') for upper thresholds is applied (table 6) to take mobile measurement equipment accuracy into account. Lower thresholds remain as per table 5.

Upper Thresholds (PEMS tests) (mg/km) (PN unit-less)		Gross Excess Threshold (mg/km) (PN unit-less)
	Petrol	Diesel	Petrol
HC	150	135	225
NOx	90	120	135
CO	1500	750	2250
PM	6,75	6,75	10,125
PN	9E+11	9E+11	6,0E+12
		CF:	1,5

Table 6: Upper- and Gross Excess Thresholds for petrol and diesel engine cars (PEMS tests)

The sum of scores for the WLTC, PEMS and BAB130 tests is divided by the maximum number of points available (34) and multiplied by 10 to establish the Clean Air Index.

1.4 Rating Box 2: Energy Efficiency

To rate all cars on the same yardstick for use of energy, fuels are converted to energy content. This will allow direct rating comparison between different fuelling and propulsion unit system architectures on a

Tank-to-Wheel basis for the moment (in kWh / 100 km). Therefore, the energy content of the fuel used in the laboratory tests will be calculated. Tests will be carried out with reference fuel in the lab, assuming one average conversion factor for petrol and one for diesel. However, as reference fuel comes with a declaration of energy content, it is easy to monitor if the conversion factors of the fuels used align with the default factors used for calculation in the spreadsheet and to make further adaptations if needed.

This, to build a solid basis to transition to Well-to-Wheel basis between 2025 and 2030 and finally to life cycle assessment after 2030.

Should it be decided in future to allow a variety of fuel variants in lab tests, the rating spread sheet can be adapted accordingly by introducing a menu with different conversion factors for different fuels (table 7).

Fuel type	Calculation Factor
Petrol RON 95, E10	8.67
Diesel B7	9.86
CNG	[tbd]
LPG	[tbd]
Electrical energy	1.00

Table 7: Calculation Factors for different fuel types (CNG, LPG still to be determined)

The energy efficiency rating is based on the measurements in the laboratory tests only. PEMS tests are considered not suitable yet for energy efficiency rating. In order to develop and decide on lower and upper thresholds, assumptions were made based on average real-world fuel / energy consumption of the fleet today. Scores are rounded to one decimal. Thresholds were set identical for all tests (table 8):

		Equals approximately	
	Energy consumption	Petrol	Diesel
Lower threshold	40 kWh/100km	4.6 l/100 km	4.1 l/100 km
Upper threshold	90 kWh/100km	10.4 l/100 km	9.1 l/100 km

Table 8: Upper and Lower thresholds for energy use

The Energy Efficiency box includes a placeholder for future testing to which 5 points are already allocated. On one hand this ensures that consumers will more likely be able to compare the results for a longer period, even when some new tests are introduced. On the other hand this ensures that energy efficiency of vehicles equipped with an electrified propulsion today will need to be further improved through innovation in terms of driving range, speed of recharge, TtW energy consumption and driving resistance, to be awarded with the maximum achievable rating.

Hence, the maximum number of points that can be achieved in the box is 34 -see table 3 for points distribution over the tests.

1.5 Test Details

In a separate info-box, in addition to some car specifications, fuel/energy consumption figures in WLTC are reported to the consumer.

To allow consumers and other stakeholders to identify to what vehicle variant and version a rating is concerned, the tested version is not only specified by its brand and model name, but also by its body style, power unit, gearbox and if needed other characteristics.

Also the car mass, an important fundamental parameter in the level of exhaust gas emissions and energy consumption, is reported. The mass is the 'actual mass' value from the vehicle's Certificate of Conformity for the moment. This may be replaced with test vehicle weighted mass in due course.

1.6 Overall Rating

The imaginary example (fig. 2) shows how the '2018 rating' is calculated and visualised. Index for Clean Air (6.2 out of 10) and Energy Efficiency (3.4 out of 10) lead to a 2-starrating. Although pollutant emissions are low and the car qualifies for a 3-star rating based on that aspect, the overall rating is determined by the weakest link, in this case the efficiency index. The items Driving Range and Driving Resistance are placeholders for the time being and will be implemented once the Roadmap has evolved further.

Fig. 2: overall result