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ACEA Input to

ENVIRONMENTALLY FRIENDLY VEHICLE (EFV)

Draft Feasibility Statement

1st April 2009

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0. EXECUTIVE SUMMARY

………………………………..

1. INTRODUCTION

1.1. BACKGROUND

Tackling climate change and improving energy efficiency are two of the major challenges currently facing transport policymakers around the world. In this context, the development and introduction of EFV's as well as renewable fuels are the main fields of action. This issue concerns us all: the government, the industry, the research community and the consumers. Nobody can and must shirk from the responsibility for protecting health and tackling climate change especially with regard to safeguarding the life support systems for future generations.

The presentations and discussions at the 3rd EFV Conference in Dresden as well and at previous conferences in Tokyo (2003) and Birmingham (2005) as well as in WP.29 have shown that we can only jointly meet the current challenges. The presentations and the conclusion paper of the Dresden conference are available on the website of Federal Ministry of Transport, Building and Urban Affairs (http://www.bmvbs.de/g8-2007). The essential results of the 3rd EFV Conference are the following:

- The United Nations expect that between 2000 and 2030 the global vehicle population will double from 800m to 1.6 billion vehicles. Given this growth it is essential to take action now to achieve a greater use of EFV's and advanced technologies.
- In an integrated approach, all road transport players have to be involved in the reduction of CO_2 and pollutant emissions and where possible technical neutral approach should be followed. Increasing the use of environmentally friendly and sustainable alternative energy sources like for example advanced biofuels (biodiesel, bioethanol, biomethane, synthetic biofuels) or renewable hydrogen and electricity are some of the essential fields of action.
- Measures to support the introduction of EFV's should be based on a common understanding. This means that we jointly should develop a globally harmonised method for evaluating the environmental friendliness of a vehicle taking into consideration regional differences.
- In developing an evaluation method, focussing solely on the vehicle will not yield the required results. Rather, the development has to be based on a holistic approach. Energy consumption and the emission of greenhouse gases have to be evaluated on the basis of an integrated ″well-to-wheels″ approach which comprises both the preceding fuel provision chain (″well-to-tank″) and the fuel use in the vehicles (″tank-to-wheels″). In the long run, the possibility of an extensive lifecycle evaluation, which also takes into account the following issues development - production - use - disposal of vehicles, should be examined as well. This should be further developed beyond the vehicle lifecycle considering also interfaces like vehicle and energy supply infrastructure, driver – vehicle interaction (e.g. ITS) and other elements in an Integrated Approach.

- It is recommended to have a close cooperation with the World Forum for Harmonisation of Vehicle Regulations (WP.29) of the United Nations in Geneva (UN-ECE).
- Future EFV Conferences is to be held every two years and should focus on the following issues:
  - status report regarding the set goals,
  - exchange of experiences with regard to ongoing measures for promoting / introducing EFV's,
  - exchange of experiences and problem analysis regarding the legal and economic framework,
  - regular status report to the G8-Leaders (according to the decision at Heiligendamm).

1.2. OBJECTIVE OF THE EFV INFORMAL GROUP

To continue a fruitful cooperation between WP.29 and the future EFV conferences, as parallel activity an informal group under GRPE was established. In a first step the task of the informal group is to prepare a review of the feasibility of the proposed EFV concept (evaluation method, holistic approach). Taking the idea of world wide harmonization into account, the applicability of the EFV concept needs to be considered for all regions of the world. Therefore following work packages are foreseen:

- The available literature and concepts, including regulations and standards, shall be screened and analysed.
- In a first step mainly energy efficiency and CO_2 emissions is considered and assessed on the basis of an integrated ″well-to-wheels″ approach.
- The feasibility of the successful development of a harmonised evaluation method should be examined and assessed.

The EFV concept requires an involvement of the two environmental GR groups of WP.29: GRPE (pollutant emissions, fuel consumption/CO_2) and GRB (noise). In addition assistance is needed from further experts i.e. those dealing with well to wheel aspects.

1.3. PREPARATION OF A FEASIBILITY STATEMENT

- Feasibility study limited to vehicles of category 1-1 (Special Resolution No. 1)

- Introduction concerning chapter 3.

- General introduction concerning the important discussion about the target groups (governments, industry, consumers) of the evaluation concept and the allocated purposes. This will include a brief description of "EFV measures".

- Aspects for the development of an evaluation concept (criteria, tools, SWOT).

- Development of the concluding feasibility statement.

< *further input expected* >

2. DEFINITIONS

2.1. ENVIRONMENTALLY FRIENDLY VEHICLE

- Common definition of EFV does not exist.

- The term EFV as well as EEV (…), green vehicle, eco-car, etc. is often used in the context of regulations, assessment concepts and environmental measures.

- The Term ″environmentally friendly″ shall not be used according to ISO 14021 (see 3.9.). Section 5.3 (Terms and definitions) of ISO 14021defines:

  "An environmental claim that is vague or non-specific or which broadly implies that a product is environmentally beneficial or environmentally benign shall not be used. Therefore, environmental claims such as "environmentally safe", "environmentally friendly", "earth friendly", "non-polluting", "green", "nature's friend" and "ozone friendly" shall not be used." This point was incorporated in the international standard to avoid the misuse of unsubstantiated environmental claims for advertising and marketing purposes.

  The reason for this ISO rule is that environmentally friendly is a very comprehensive and bold statement that is not likely to be justifiable. It might be the case that e.g. a vehicle has lower NO_x emissions than another vehicle during its life-time. However, 'environment' is much more than NO_x emissions and need to take into consideration also other relevant items as for example CO_2 emissions or heavy metals. In consequence, a vehicle having lower CO_2 emissions might be identified as a low-CO_2-emission-vehicle but not necessarily "environmentally friendly". ISO requires a specific, not misleading terminology.

2.2. LIFE CYCLE ASSESSMENT (LCA)

Life Cycle Assessment (LCA) is a method detailed in ISO 14040/44 to compile and evaluate inputs, outputs and the potential environmental impacts of a product system throughout its life cycle. The life cycle consists of all processes respectively consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to final disposal. Thus the scope goes beyond a well-to-wheel approach as – for the case of vehicle LCAs – covering not only the generation of fuels to its use in vehicles but also the generation of all materials needed to produce a vehicle to its final end-of-life vehicle stage [1].

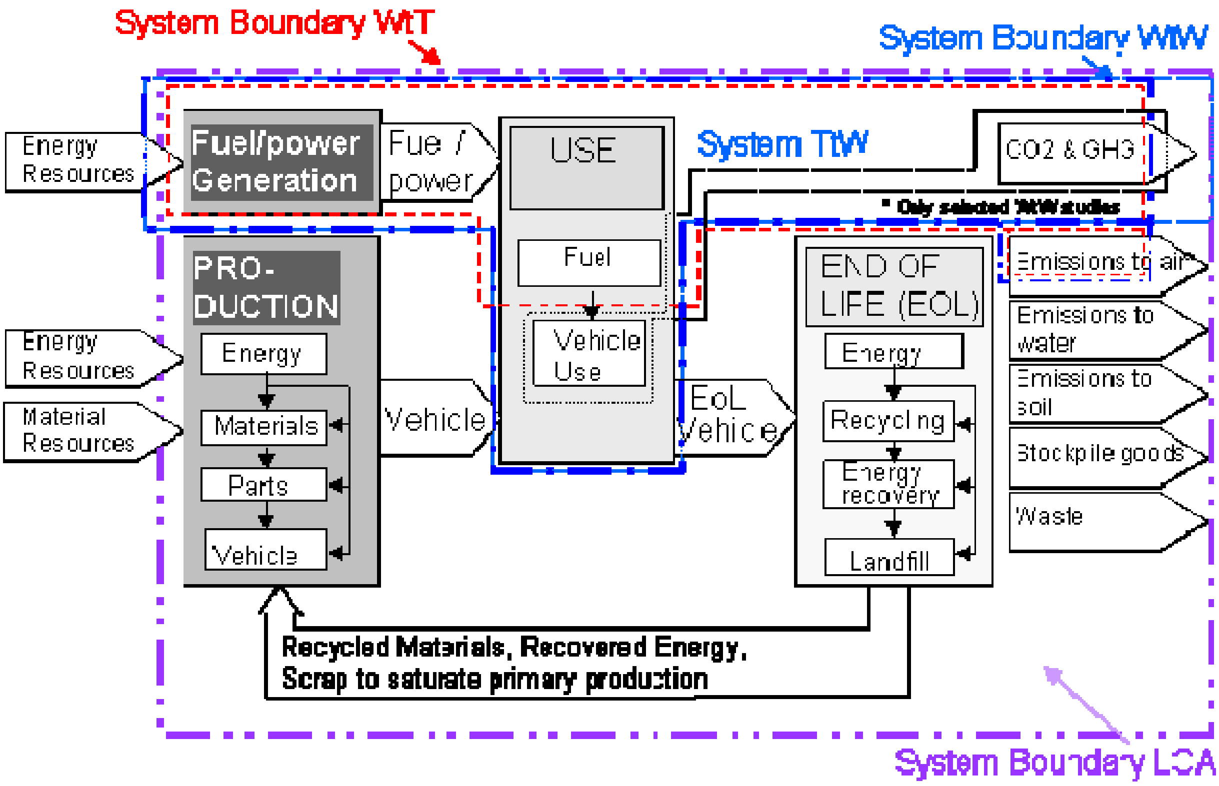


Fig. 2.2-1: Scheme of Life Cycle Assessment method [Schmidt et al., 2004].

2.3. WELL TO WHEEL (WELL TO TANK, TANK TO WHEELS)

Well to Tank (WTT) evaluations account for the energy expended and the associated GHG emitted in the steps required to deliver the finished fuel into the on-board tank of a vehicle. They cover the steps extracting, transporting, producing and distributing the finished fuel [2].

The Tank to Wheels (TTW) evaluation accounts for the energy expended and the associated GHG emitted by the vehicle in the reference driving cycle [2].

Well to Wheel (WTW) evaluations account for the energy expended and the associated GHG emitted in the steps fuel production (Well to tank) and vehicle use (tank to wheel) [2].

2.4. FUEL EFFICIENCY, FUEL CONSUMTION, ENERGY USE

< further input expected >

2.5. ENERGY EFFICIENCY

Efficiency is the ratio of the output to the input [3]. Energy efficiency refers to products or systems designed to use less energy for the same or higher performance than regular products or systems [4].

- [Ratio of energy output of a conversion process or of a system to its energy input [5].]
- [Conversion ratio of output and input energy of energy production technologies and end-use appliances. The lower the efficiency, the more energy is lost [6].]

2.6. ENERGY MIX

Energy mix is the combination of coal, oil gas, nuclear hydro biomass & waste and other renewables chosen to respond to the energy demand. As example the mix for the European energy use is shown:

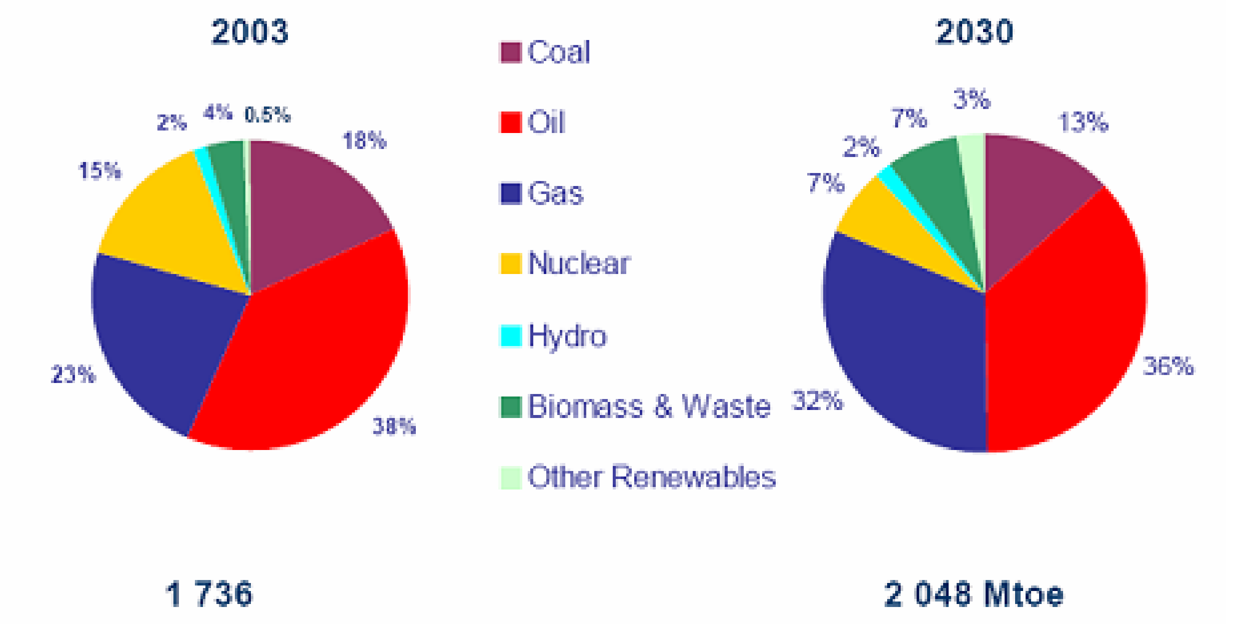


Fig. 2.6-1: Energy mix for EU.

- Resource availability is influencing the share in this combination of each energy sources.

For Example: Energy for Electricity Generation

Energy for generation of electricity is primarily supplied by the fossil fuels of coal, oil and natural gas, nuclear energy, hydro electric power, and more recently, the emergence of large wind and multi megawatt scale photovoltaic applications. Political and economic drivers are the forces that have determined what mix of these energy sources we utilize.

Electricity generation worldwide is currently dominated by the combined energy from the fossil fuels coal, oil and natural gas (Figure 2.6-2). Replacing these sources with sustainable sources is an enormous challenge. Sustainable options are hydro power, wind, and solar, either as solar thermal power plants or as photovoltaic power. At present wind energy is a rapidly growing contributor to electricity generation with annual installed capacity figures still increasing by about 30% per annum. Total world installed wind generation capacity exceeded 100,000 MW in the summer of 2008, but even this leaves wind as a small although important and growing overall contributor. As oil and coal prices increase, the economics of wind power improve and the wind industry will continue to grow at high rates for the foreseeable future. Some regions of

Germany have 20% to 30% of their electricity production from wind machines. Wind power production will become a larger and larger player in world electricity generation, and wind's present growth rate is limited by the number of manufacturers and their annual production capacity. The percentage of wind generation that a grid can support is also limited by conventional grid designs, but with pumped storage and other reactive power controls, wind penetration into grids could be increased.

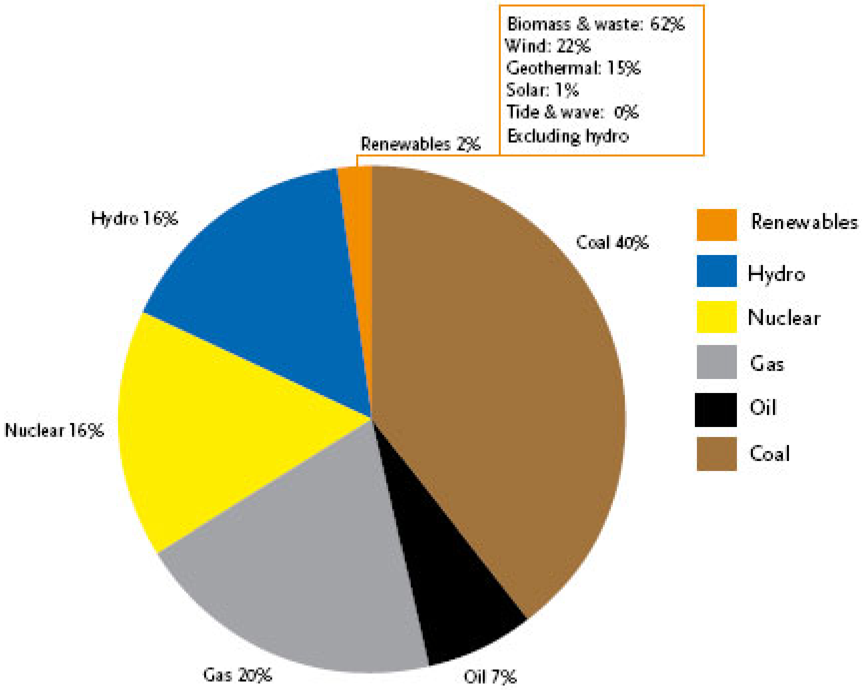


Fig. 2.6-2: World electricity by energy source (IEA 2004).

2.7. LIFETIME; USEFUL LIFE; LIFE CYCLE

- Lifetime:
  Lifetime of a vehicle is defined as the time from start of usage until end of vehicle life. The end of vehicle life depends on the individual decision of the car owner whether the car will be sold to other persons or markets or the car will be recycled according to existing legislation. Therefore lifetime of a vehicle is always an expert guess and can not be measured or defined precisely [7, 8].

- Useful life:

	Reference	Comment
Europe	**European Union:** (EC) 692/2008 (Euro 5/Euro 6) *ANNEX VII* VERIFYING THE DURABIL-ITY OF POLLUTION CON-TROL DEVICES (TYPE 5 TEST) *ANNEX II* IN-SERVICE CONFORMITY	The whole vehicle durability test represents an ageing test of 160 000 kilometers driven on a test track, on the road, or on a chassis dynamometer. As an alternative to durability testing, a manufacturer may choose to apply the assigned deterioration factors from the following Tab. For ISC checking vehicles are selected up to 100.000 km.
USA	**Code of Federal Regulations (CFR):** PART 86 - CONTROL OF EMISSIONS FROM NEW AND IN-USE HIGHWAY VEHICLES AND ENGINES (CONTINUED) **§ 86.1805–04**	The full useful life for all LDVs, LDT1s and LDT2s is a period of use of 10 years or 120,000 miles, whichever occurs first. For all HLDTs, MDPVs, and complete heavy-duty vehicles full useful life is a period of 11 years or 120,000 miles, whichever occurs first. This full useful life applies to all exhaust, evaporative and refueling emission requirements except for standards which are specified to only be applicable at the time of certification. Manufacturers may elect to optionally certify a test group to the Tier 2 exhaust emission standards for 150,000 miles to gain additional NOX credits, as permitted in § 86.1860–04(g), or to opt out of intermediate life standards as permitted in § 86.1811–04(c). In such cases, useful life is a period of use of 15 years or 150,000 miles, whichever occurs first, for all exhaust, evaporative and refueling emission requirements except for cold CO standards and standards which are applicable only at the time of certification.

For automotive LCA, EUCAR agreed to base the passenger car assessments on 150.000 km. However, it is common practice of OEMs to apply different mileages in different vehicle segments.

- Life cycle:
  Life cycle is defined as the consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal [9].

2.8. INTEGRATED APPROACH

Integrated approach means the adoption of a comprehensive strategy involving all relevant stakeholders (i.e. vehicle manufacturers, oil/fuel suppliers, customers, drivers, public authorities, etc.). The underlying assumption in support of such an approach is that improvements can be achieved more efficiently by exploiting the synergies of complementary measures and optimising their respective contributions rather than by focusing on improvements in car technology alone. An integrated approach would provide for:

- Greater potential for environmental benefit when more elements of the system are covered;
- Greater potential for the identification of the most-cost effective options;
- Policy coherence giving more scope for synergies and avoidance of perverse effects;
- A fair distribution of the burden between different stakeholders.

The integrated approach implies building links with other policy areas. Some of the measures which would contribute to environmental benefits also have the potential to enhance road safety. Such synergies should be exploited. The integrated approach combines further developments in vehicle technology with an increased use of alternative fuels, intelligent traffic management, changes in driving style and car use, and environmentally-related taxation. This requires partnership between the fuel industry, policy makers, drivers and the automotive industry.

2.9. SWOT ANALYSIS

The SWOT analysis combines an investigation of the strength, weakness, opportunities, and threats of a method. [Reference?]

[For the purpose to develop an EFV evaluation method, the SWOT concept can be used. SWOT is based on appropriate criteria to check whether these methods are comprehensive enough (environmental aspects covered, system boundaries) while being still applicable and realistic (data, effort for application, comparability).]

< further input expected >

3. EXISTING LEGISLATION, TOOLS FOR HOLISTIC APPROACHES AND ASSESSMENT CONCEPTS

3.1. REGULATIONS AND STANDARDS

3.1.1. JAPAN

3.1.1.1. TOP RUNNER PRINCIPLE

The ″Top runner approach″ has been introduced in Japan in 1998 when revising the Japanese Energy Conservation Law and consecutive government ordinances. In summary, the Japanese Top Runner uses, as a base value, the value of the product with the highest energy efficiency on the market at the time of establishing standards for such products. Standard values are set taking into account potential technological improvements leading to better energy efficiency. The producer is allowed to conform to the standard by ″average fleet″: all products should achieve this level of energy efficiency performance after a certain time frame. In case of non-compliance after expiry of the given transition period, firstly, the manufacturer of the product would be "advised" to ensure the product's compliance in a "recommendation" issued to him by the Ministry of Economy, Trade and Industry (METI). If the non-compliance continues, the manufacturer will be challenged by a system of marking poor performing products and may potentially be penalised. If penalised, such sanctions would amount up to a maximum of 1 Mio. Yen, that is some 7400 Euro. We are not aware of any penalties issued to date.

Compliant products may be labelled voluntarily under the top runner approach. Therefore, labelling can vary between products belonging to the same targeted product group. 21 product groups are targeted by the top runner in Japan including automotive applications.

The Japanese top runner focuses on the energy aspect solely. The approach does not restrict market access for any product, whether the particular product meets the target standard or not. The Japanese top runner mainly works with a "name and shame" marking scheme.

3.1.1.2. EXHAUST GAS EMISSION

Tab. 3.1.1.2-1: Exhaust Emission Limit – Gasoline and LPG fuelled vehicles.

	Test Mode [1]	Unit	CO	HC	NOx	PM [2]	New Model	All prod. / Imported veh.
New Short Term (Mean / Max)								
PC	10-15 Mode	g/km	0.67/1.27	0.08/0.17	0.08/0.17	-	Oct. 2000	Sep. 2002
	11 Mode	g/test	19.0/31.1	2.20/4.42	1.40/2.50	-		
Mini Com Veh	10-15 Mode	g/km	3.30/5.11	0.13/0.25	0.13/0.25	-	Oct. 2002	Sep. 2003
	11 Mode	g/test	38.0/58.9	3.50/6.40	2.20/3.63	-		
Light CV	10-15 Mode	g/km	0.67/1.27	0.08/0.17	0.08/0.17	-	Oct. 2000	Sep. 2002
	11 Mode	g/test	19.0/31.1	2.20/4.42	1.40/2.50	-		
Medium CV	10-15 Mode	g/km	2.10/3.36	0.08/0.17	0.13/0.25	-	Oct. 2001	Sep. 2003
	11 Mode	g/test	24.0/38.5	2.20/4.42	1.60/2.78	-		
New Long Term (Mean / Max)				**NMHC**				
PC	10-15 Mode + 11 Mode	g/km	1.15/1.92	0.05/0.08	0.05/0.08	-	Oct. 2005	Sep. 2007
Mini Com Veh			4.02/6.67	0.05/0.08	0.05/0.08	-	Oct. 2007	Sep. 2008/ Sep. 2007
LCV			1.15/1.92	0.05/0.08	0.05/0.08	-	Oct. 2005	Sep. 2007
Medium LCV			2.55/4.08	0.05/0.08	0.07/0.10	-	Oct. 2005	Sep. 2007
Post New Long Term [3] **-** Proposed on 8th Recommendation from the Central Environmental Counsel - Amended in November 2007 **(Mean/Max)**								
PC	JC08H + JC08C	g/km	1.15/1.92	0.05/0.08	0.05/0.08	0.005/0.007	Oct. 2009	Oct. 2009/ Sep. 2010
LCV			1.15/1.92	0.05/0.08	0.05/0.08	0.005/0.007	Oct. 2009	Oct. 2009/ Sep.
2010Medium LCV			2.55/4.08	0.05/0.08	0.07/0.10	0.007/0.009	Oct. 2009	Oct. 2009/ Sep. 2010

[1] Test mode: see pages 42-43 [2] PM limit applied to direct injection gasoline engine to which NOx absorber
[3] New PM measurement method; technically modified methods for CO and other gases

Tab. 3.1.1.2-2: Exhaust Emission Limit – Diesel vehicles.

	Test Mode[1]	Unit	CO	HC	NOx	PM	New Model	All prod. / Imported veh.
New Short Term (Mean / Max)								
PC ≤ 1265 kg	10-15 Mode	g/km	0.63/0.98	0.12/0.24	0.28/0.43	0.052/0.11	Oct. 2002	Sep. 2004
PC > 1265 kg			0.63/0.98	0.12/0.24	0.30/0.45	0.056/0.11	Oct. 2002	Sep. 2004
Light Com Veh			0.63/0.98	0.12/0.24	0.28/0.43	0.052/0.11	Oct. 2002	Sep. 2004
Med. Com Veh			0.63/0.98	0.12/0.24	0.49/0.68	0.06/0.12	Oct. 2003	Sep. 2004
New Long Term (Mean / Max)				**NMHC**				
PC ≤ 1265 kg	10-15 Mode + 11 Mode	g/km	0.63/0.84	0.024/0.032	0.14/0.19	0.013/0.017	Oct. 2005	Sep. 2007
PC > 1265 kg			0.63/0.84	0.024/0.032	0.15/0.20	0.014/0.019	Oct. 2005	Sep. 2007
Light Com Veh			0.63/0.84	0.024/0.032	0.14/0.19	0.013/0.017	Oct. 2005	Sep. 2007
Med. Com Veh			0.63/0.84	0.024/0.032	0.25/0.33	0.015/0.020	Oct. 2005	Sep. 2007
Post New Long Term[4] **-** Proposed on 8th Recommendation from the Central Environmental Counsel - Amended in November 2007 **(Mean/Max)**								
PC	JC08H + JC08C	g/km	0.63/0.84	0.024/0.032	0.08/0.11 [3]	0.005/0.007	Oct. 2009	Oct 2009/ Sep 2010
LCV			0.63/0.84	0.024/0.032	0.08/0.11	0.005/0.007	Oct. 2009	Oct 2009/ Sep 2010Medium
LCV			0.63/0.84	0.0240.032	0.15/0.20	0.007/0.009	Oct. 2010 [2]	Oct 2009/ Sep 2010 [2]

1) Test mode: see pages 42-43
2) Oct 2010 for Medium Commercial Vehicle w/ 1.7 t < GVW ≤ 2.5 t or Oct 2009 for Medium Commercial Vehicle w/ 2.5 t < GVW ≤ 3.5 t
3) For vehicles not exceeding 1.265 kg. For vehicles > 1.265 kg: 0.15/0.20
4) New PM measurement method; technically modified methods for CO and other gases

Other Requirements:

- From 2005:
  HC is measured as NMHC
  Light Weight Commercial Vehicles ≤ 1.7 t GVW (diesel and gasoline)
  Medium Weight Commercial Vehicles: 1.7 < GVW ≤ 3.5 t (diesel and gasoline)
  For vehicles powered by fuels other than gasoline, LPG or diesel:
  - Test method is 10.15 mode + JC08C until 31 March 2011 (28 Feb 2013 for imported vehicle); after: JC08H + JC08C
  - Emission limits are similar to the relevant 2009 vehicle regulation
  - Application date: domestic vehicle: 01 Oct 2009; imported vehicle: 01 Sep 2010

- Test Mode:
  Exhaust Emission Level will be calculated as below:
  From Oct 2005: 10-15 mode hot start x 0.88 + 11 mode cold start x 0.12
  From Oct 2008: 10-15 mode hot start x 0.75 + JC08 mode cold start x 0.25
  From Oct 2009: JC08 mode hot start x 0.75 + JC08 mode cold start x 0.25

- Mean / Max:
  Mean: to be met as a type approval limit and as a production average
  Max: to be met as type approval limit if sales are less than 2000 per vehicle model per year and generally as an individual limit in series production

- Idle CO & HC – Gasoline and LPG:
  Idle CO: 1per cent, Idle HC: 300 ppm

- Durability:
  PC, truck and bus GVW < 1.7t: 80,000 km
  PC, truck and bus GVW > 1.7t: 250,000 km
  DF: 10-15 Mode: CO: 0.15; HC: 0.15; NOx: 0.25
  11 Mode: CO: 2.0; HC: 0.15; NOx: 0.20
  JC08 mode: CO: 0.11; NMHC: 0.12; NOx: 0.21

- Evaporative Emissions – Gasoline and LPG:
  Test similar to EC 2000 Evap test
  (1 h hot soak at 27± 4°C + 24 h diurnal (20-35°C)),
  test limit: 2.0 g/test, run on 10-15 Mode (three times).
  Preparation driving cycle for EVAP:
  25 sec. Idle + 11 mode x4 + ((24 sec. Idle + 10 mode x3 + 15 mode) x3)

- OBD – Diesel, Gasoline and LPG:
  Current status: Vehicles to be equipped with OBD similar to EOBD requirements
  OBD requirement for Passenger Cars and Commercial Vehicles with GVW ≤ 3.5 tons from October 2008

- Smoke – Diesel:
  4-mode: opacity limit 25per cent; free acceleration limit 25 per cent; Max PM: 0.8 m-1
  From 2009: diesel 4-mode is abolished.; Max PM: 0.5 m-1

- Fuel quality – Sulphur content:
  Diesel: from Jan 2007: 10 ppm
  Gasoline: current: 50 ppm; from Jan 2008: 10 ppm

- NO_x – PM Law:

Tab. 3.1.1.2-3: NO_x – PM Law (Applicable in following metropolis: Tokyo, Saitama, Chiba, Kanagawa, Aichi, Mie, Osaka, Hyogo)

	Weight category	NOx	PM
Diesel PC	-	0.25 g/km	0.026 g/km
Bus & truck	GVW ≤ 1.7 ton	0.25 g/km	0.026 g/km
	1.7 < GVW ≤ 2.5 ton	0.4 g/km	0.03 g/km
	2.5 < GVW ≤ 3.5 ton	4.5 g/kWh	0.09 g/kWh

If a vehicle does not satisfy the regulation limit it cannot be registered in the applicable area after grace period.

Grace period from 1st registration:
Diesel PC: 9 years
Small truck: 8 years
Small bus: 10 years

Local Ordinance on Diesel Vehicles – PM Emission Regulation

Tab. 3.1.1.2-4: Local Ordinance on Diesel Vehicles – PM Emission Regulation (Applicable in whole area of Tokyo (exclude island area), Saitama, Chiba, Kanagawa)

Diesel truck & bus	From Oct 2003	From April 2006*
GVW ≤ 1.7 ton	0.08 g/km	0.052 g/km
1.7 < GVW ≤ 2.5 ton	0.09 g/km	0.06 g/km
2.5 ton < GVW	0.25 g/kWh	0.18 g/kWh

* In case of Tokyo and Saitama only

Vehicles from outside the mentioned area will not be able to operate within the cities unless of equal standard to city vehicles.

Two exemptions:
- Vehicles less than 7 years old (which must meet new vehicle emissions for 7 years from registration)
- Vehicles fitted with a PM filter

Driving Cycles:

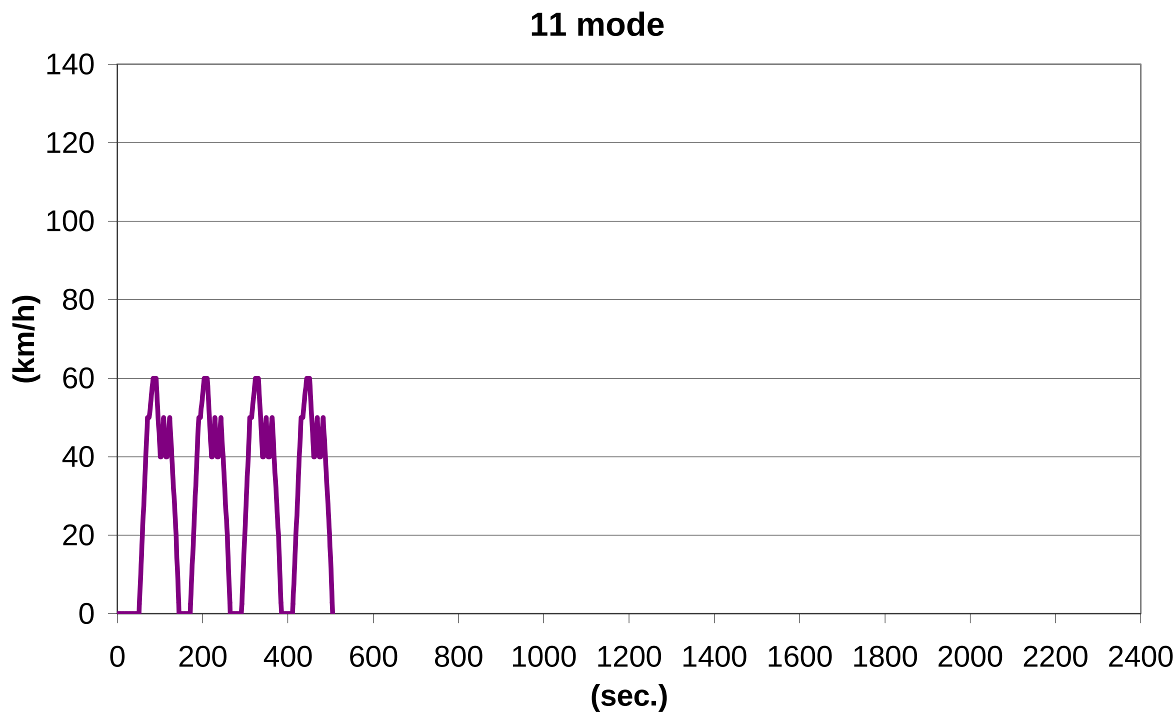


Fig. 3.1.1.2-1: Driving Cycle Japan 11 mode cold cycle.

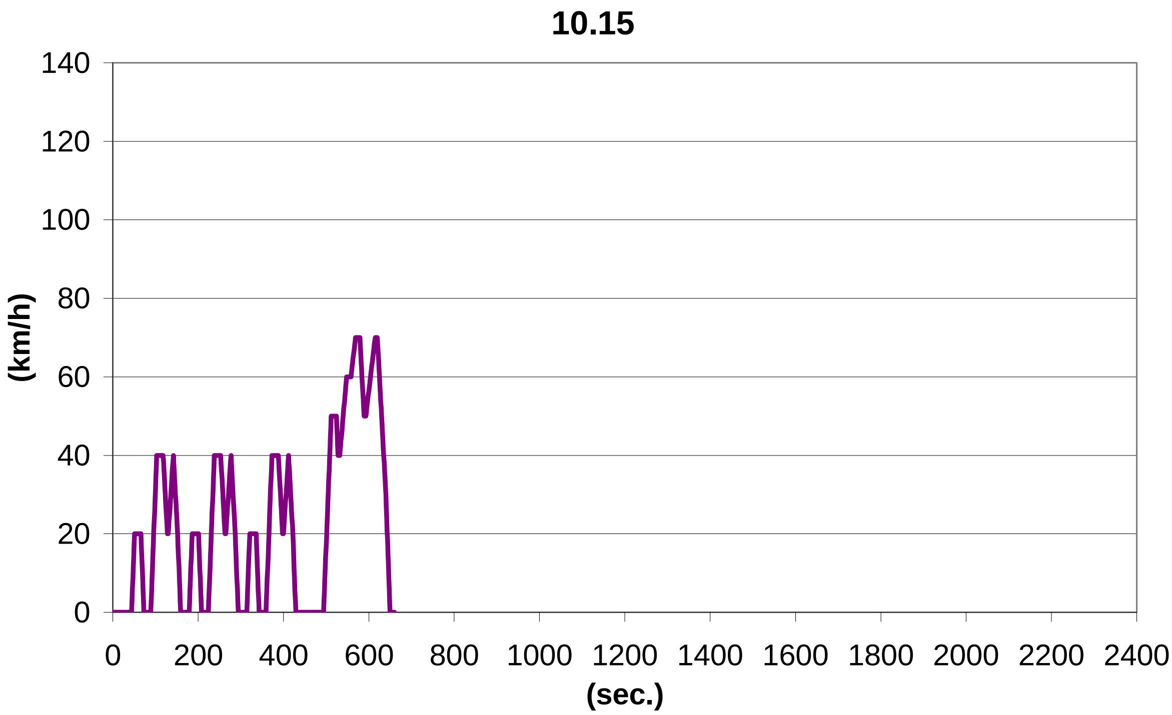


Fig. 3.1.1.2-2: Driving Cycle Japan 10.15 mode hot cycle.

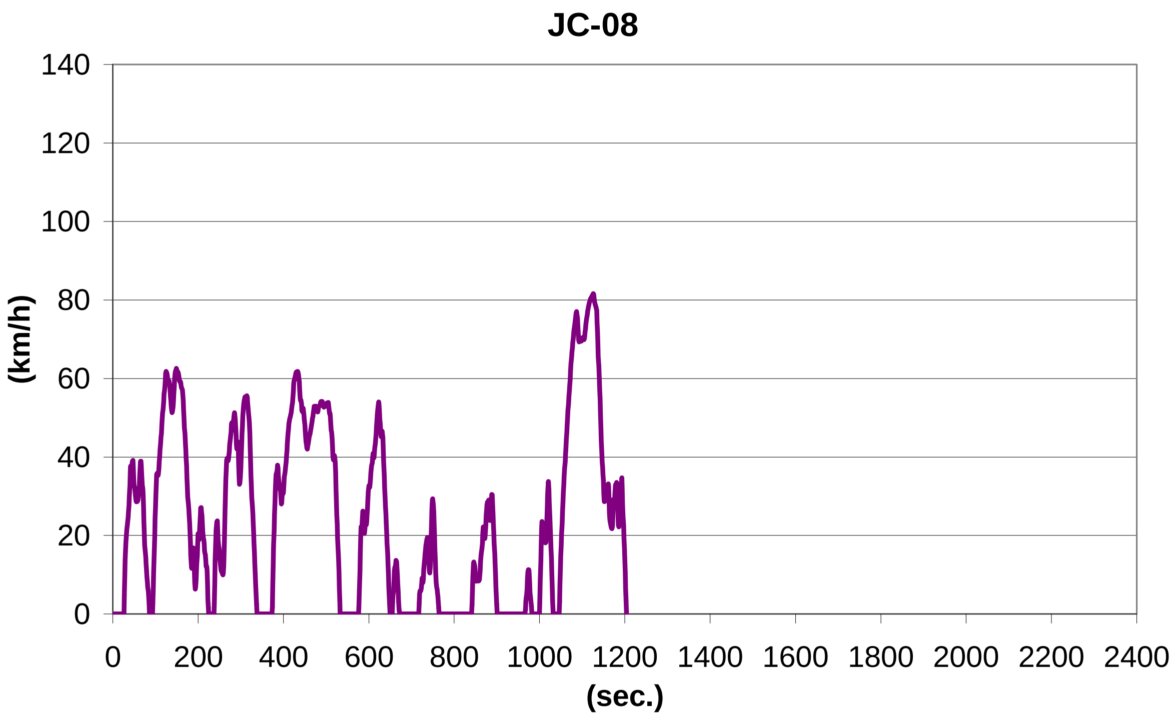


Fig. 3.1.1.2-3: New Driving Cycle Japan JC 08.

Tab. 3.1.1.2-5: Driving cycle summary.

Time (excl. soak)	1204 s
Distance	8172 m
Max. Speed	81.6 km/h
Ave. Speed	24.4 km/h
Soak	Repeated as hot test
Gear shift (man)	Fixed speeds

3.1.1.3. FUEL EFFICIENCY

< Explanation needed >

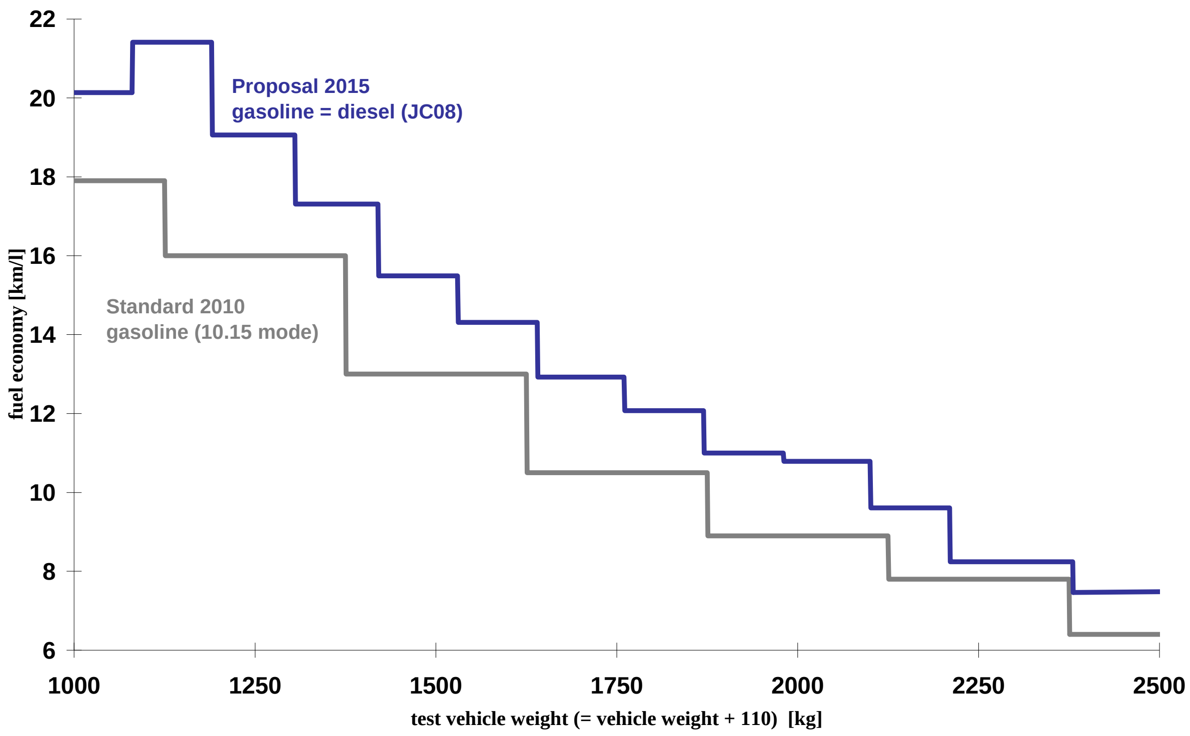


Fig. 3.1.1.3-1: Japanese fuel efficiency legislation.

3.1.1.4. EFV APPROACH IN JAPAN *< or chapter 3.3.1.5. >*

< further input expected >

3.1.1.5. NOISE

Reducing Automobile-Emitted Noise [10]:

Reducing motor vehicle and road traffic noise constitutes a major environmental issue. Automobiles generate various kinds of noise, including the noise emitted by the engine, the intake system, the drivetrain, the cooling system, and the exhaust system. In addition, tires generate

tire/road noise. Automotive noise in Japan is regulated by standards—on accelerated running noise, steady running noise, and stationary exhaust proximity noise—which have become progressively more stringent, requiring automobile manufacturers to develop the technologies necessary for compliance. All motor vehicles manufactured as of September 2003 comply with the latest noise standards.

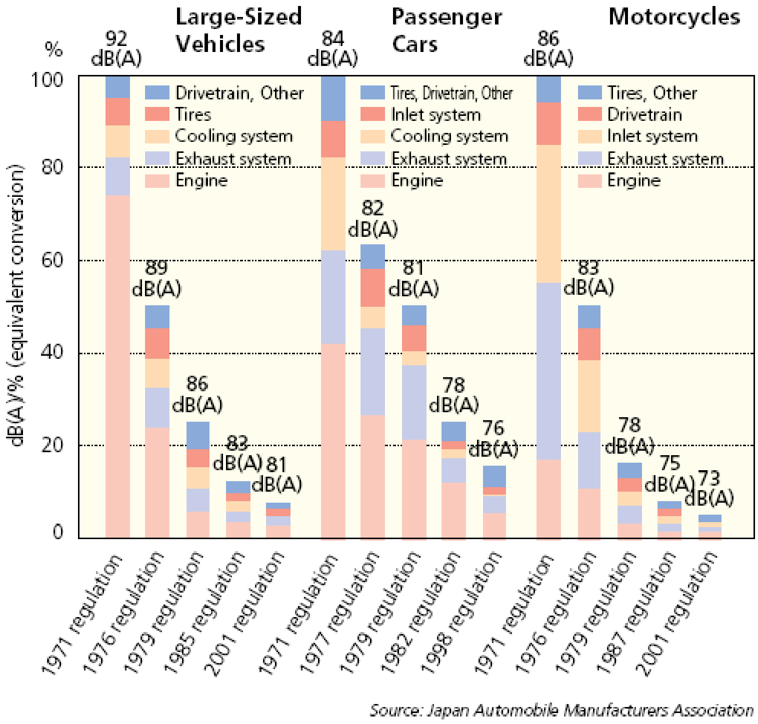


Fig. 3.1.1.5-1: The progress in motor vehicle noise reduction (accelerated running noise).

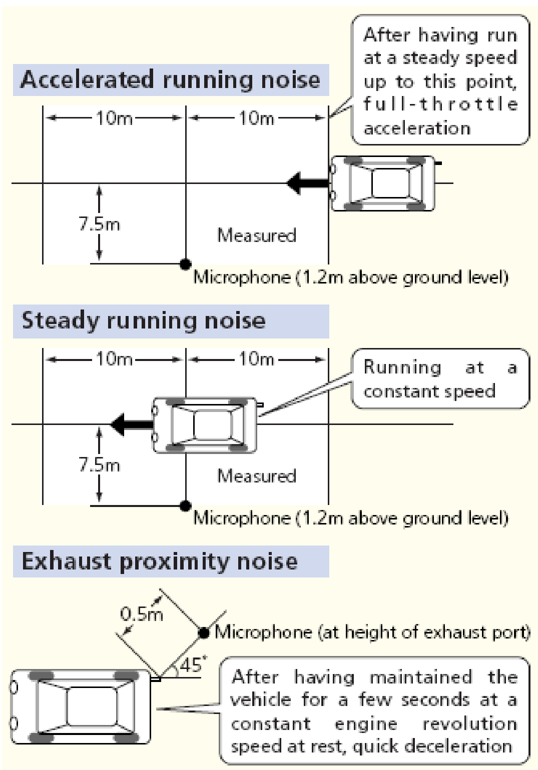


Fig. 3.1.1.5-2: Testing motor vehicle noise levels.

Tab. 3.1.1.5-1: Overview of japan’s motor vehicle noise regulations (for accelerated running noise).

Vehicle Type				Regulation 1971	1976-1977	1979	1982-1987	1998-2001
Large-Sized Vehicles	Vehicles with GVW=over 3.5 tons and maximum engine output=over 150 kW	4WD vehicles, etc.		92	89	86	83	82
		Trucks						81
		Buses						81
Medium-Sized Vehicles	Vehicles with GVW=over 3.5 tons and maximum engine output=up to 150 kW	4WD vehicles, etc.		89	87	86	83	81
		Trucks						80
		Buses						80
Small-Sized Vehicles	Vehicles with GVW=up to 3.5 tons	Other than mini-vehicles	GVW=Over 1.7 tons	85	83	81	78	76
			GVW=Up to 1.7 tons					76
		Mini-vehicles	“Bonnet” type					76
			Cab-over-engine type					76
Passenger Cars	Vehicles exclusively for the transport of passengers, with up to 10-passenger occupancy	Over 6 occupants		84	82	81	78	76
		6 occupants or fewer						76
Motorcycles	Small-sized motorcycles (over 250cc) and mini-sized motorcycles (126cc-250cc)	Small-sized		86	83	78	75	73
		Mini-sized		84				73
Motor-Driven Cycles	Class 1 motor-driven cycles (50cc & under) and Class 2 motor-driven cycles (51cc-125cc)	Class 2		82	79	75	72	71
		Class 1		80				71

Notes: 1. In pre-1987 regulations, “150 kW” reads “200 horsepower.” 2. “4WD vehicles, etc.” includes 4WDs, tractors, and cranes. *Source: Ministry of the Environment*

3.1.1.6. RECYCLING

Vehicle Recycling and Waste Reduction [10]:

Under Japan’s End-of-Life Vehicle (ELV) Recycling Law which entered into force in January 2005, automobile manufacturers and importers are responsible for recovery, recycling and appropriate disposal with respect to fluorocarbons, airbags, and automobile shredder residue (ASR). Compliance with the law will enable ASR to be recycled at a rate of 70% by 2015, resulting in an automobile recycling rate of 95% (by vehicle weight) as compared with the 80% rate prevailing prior to the introduction of the law. Japan’s vehicle recycling infrastructure as mandated by its ELV Recycling Law is the first in the world to administer the entire process of auto recycling—from ELV recovery to final disposal—on the basis of electronic “manifests” (or compliance checklists). JAMA itself played a central role in the development and implementation of this advanced vehicle recycling system. It also provided financial support for related software development and continues to help finance system maintenance and improvements. In line with national efforts to “reduce, reuse, recycle,” Japan’s automakers are also striving to design vehicles using lightweight materials that are easy to dismantle and recycle, and to reduce and recycle designated waste products generated in the manufacturing process. In 2006 the total volume of auto plantgenerated waste destined for landfill disposal dropped to 6,000 tons, a decrease of 98% from the 1990 level, already largely exceeding the 2010 target of 11,000 tons.

Tab. 3.1.1.6-1: Industry measures in line with national legislation.

	Law for the Promotion of Effective Utilization of Resources (3R Law)		Distribution, Service and Consumption	End-of-Life Vehicle Recycling Law
	Product Design	Waste Management		ELV Recycling
"Reduce" initiatives	For designated products: - Weight reduction/ Downsizing - Longer product life	For designated industries: - Reduction/recycling of designated waste products generated in vehicle manufacturing operations: 1) Scrap metals 2) Casting sand residue		
"Reuse" initiatives	For designated products: - Use of recyclable materials - Ease of dismantling - Ease of sorting - Safe recyclability - Materials identification			- Recovery and recycling of: 1) ASR 2) Airbags 3) Fluorocarbons Note: Motorcycles are not covered by the ELV Recycling Law.
"Recycle" initiatives		- Total waste volume*: 1990 (baseline): 350,000t ↓ 2006: 6,000t (a 98% reduction from 1990) JAMA target: 11,000t by FY2010 *For landfill disposal, including scrap metals, casting sand residue, and other waste.		

3.1.2. USA

In the USA beside the federal regulations California deviates from this with an own system.

3.1.2.1. EXHAUST GAS EMISSION, EPA

Regulation	Reference	Comment
Auxiliary Emissions Control Devices (AECDs) & Defeat Devices	40 CFR 86.1809-01, 40 CFR 86.1803-01, 86.1844-01	This regulation requires that vehicle emissions control system effectiveness be certified in driving modes not included in the regulatory test cycles
Compliance Assurance Program (CAP 2000)	40 CFR Part 86 subpart S CAP 2000	CAP 2000 rule streamlines vehicle certification procedures and requires manufacturer funded "in-use" vehicle testing for evaporative emissions
Onboard Refueling Vapor Recovery (ORVR)	40 CFR Part 86 subparts A (prior to 2001), S (2001+), B	This rule implements new vehicle standards and test procedures for the control of emissions during refueling
US EPA MSAT Cold NMHC Exhaust Emissions Limits	40 CFR Part 86 Subpart S	US EPA requirements for PC, LDT and MDPV Cold NMHC exhaust emissions. Vehicles are required to be certified to a Cold NMHC family emissions limit (FEL) rounded to the nearest 0.1 g/mi. Sales weighted fleet average requirements of 0.3 g/mi for vehicles up to 6,000 pounds GVWR and 0.5 g/mi for vehicles over 6,000 pounds GVWR define the required mix of individaul FELs
US EPA Tier 2 Exhaust Emissions Limits	40 CFR Part 86 Subpart S	US EPA requirements for PC, LDT and MDPV exhaust emissions
Federal On-Board Diagnostics (OBD)	40 CFR, 86.094, OBD, On-Board Diagnoistics	Manufacturers are required to install an OBD system which monitors various exhaust and evaporative emission control components for malfunction or deterioration resulting in exceeding various emission thresholds and illuminates a malfunction indicator light (MIL). These requirements apply to all PCs and LDTs.
Cold Temperature CO Emission Standards	40CFR86.094-8(k) & -9(k), Cold CO for PC & LDT	The cold temperature certification CO standards at 20 oF are: · 10 g/mi for PCs
Tier 1 Exhaust Emission Standards	40CFR86.0XX-8 & -9*, Tier 1 Exhaust Emission Stds	The Tier 1 certification NMHC (nonmethane hydrocarbon), CO, NOx, and particulate matter (PM) emission standards at 50,000 and 100,000 miles, respectively, are: ·0.25/3.4/0.4/0.08 g/mi -- 0.31/4.2/0.6/0.10 g/mi for PCs,
Corporate Average Fuel Economy (CAFE)	Federal: 40 CFR, Part 600, Law: 15 U.S.C. Section 2001	Sets minimum standards for a manufacturers production-weighted average fleet fuel economy. Vehicle fuel economy is established by laboratory testing. The CAFE standard for passenger cars is 27.5 mpg.
Gas Guzzler Tax	Federal: 40 CFR, Part 600, Law: 26 U.S.C. Section 4063	For any passenger car sold in the U.S., a tax is paid if that vehicles fuel economy does not exceed a 22.5 mpg threshold. The tax increases for models with lower mpg. The tax is $1,000 if the vehicles fuel economy is between 21.5 mpg to 22.4 mpg, $1,300 for 20.5 mpg to 21.4 mpg, and increases to $7,700 if the mpg is less than 12.4 mpg.

Tier II Standard (cont'd)

Two temporary options available for MY2007-09 diesel powered vehicle:

- US06 opt: Relaxed 4k NO_x+NMHC std in exchange for 30per cent stricter composite SFTP NO_x+NMHC std. Also extends SFTP useful life to 150k.
- High Alt. Option; Bin 7/8 veh. Allowed in-use NO_x std of 1.2x the FTP std., when at high alt. In exchange, must meet Bin 5 PM std.
  lso extends the useful life to 150k for ALL FTP based tests.

New fleet average requirement for NMHC:

- Provisions for carry forward and carry-back of credits
- Prov. for carry-over programs with respect to in-use testing
- Test is on FTP cycle at 20 deg F
- Flex fueled vehicles only required to provide assurance that the same emission reduction systems are used on non-gasoline fuel as on gasoline
- LDV < 6000 GVWR:
  Meet sales weighted fleet average of 0.3 g/mi at 120k mi
  Phase in 25/50/75/100 from MY2010 - 2013
- 6000 ≤ LDV < 8500 GVWR and MDPV < 10,000 lbs
  Meet sales weighted fleet average of 0.5 g/mi at 120k mi
  Phase in 25/50/75/100 from MY2012 – 2015

Tab.3.1.2.1-1: NO_x fleet average 0,07 g/mi.

g/mi		Bin 8	Bin 7	Bin 6	Bin 5	Bin 4	Bin 3	Bin 2
NMOG	50 k	0.100	0.075	0.075	0.075			
	120 k	0.125	0.090	0.090	0.090	0.070	0.055	0.010
CO	50 k	3.4	3.4	3.4	3.4			
	120 k	4.2	4.2	4.2	4.2	2.1	2.1	2.1
NOx	50 k	0.14	0.11	0.08	0.05			
	120 k	0.20	0.15	0.10	0.07	0.04	0.03	0.02
PM	120k	0.02	0.02	0.01	0.01	0.01	0.01	0.01
HCHO	50 k	0.015	0.015	0.015	0.015			
	120 k	0.018	0.018	0.018	0.018	0.011	0.011	0.004

Tab. 3.1.2.1-2: Tier II Phase_In-Schedule in % (Vehicles < 6000 lbs GVWR).

%	'01	'02	'03	'04	'05	'06	'07	'08
NLEV	100	100	100					
(Interim Non-)Tier II, 0.3 NOx avg				75	50	25	0	0
Tier II, 0.07 NOx avg				25	50	75	100	100

Driving Cycles:

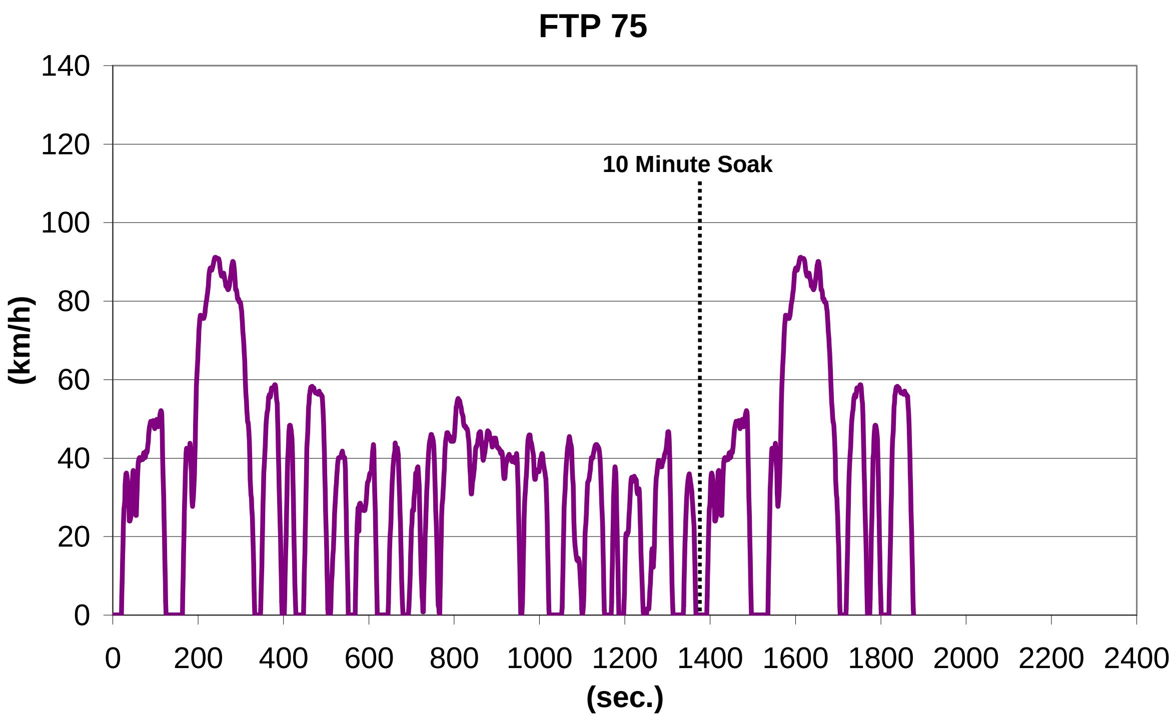


Fig. 3.1.2.1-1: Driving cycle FTP 75, EPA III (also known as: city cycle).

Tab. 3.1.2.1-3: Driving cycle summary.

Time (excl. soak)	1877 s
Distance	17860 m
Max. Speed	91.2 km/h
Ave. Speed	34.2 km/h
Soak	600 s
Gear shift (man)	Specific (with evidence)

Fig. 3.1.2.1-2: Highway cycle (also known as: Highway Fuel Economy Test-HWFET).

Tab. 3.1.2.1-4: Driving cycle summary.

Time	765 s
Distance	16500 m
Max. Speed	96.4 km/h
Ave. Speed	77.4 km/h
Soak	N/A
Gear shift (man)	Specific (with evidence)

3.1.2.2. EXHAUST GAS EMISSION, CARB

Regulation	Reference	Comment
Enhanced Evaporative Emission Regulations	California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent	Regulation adds more stringent evaporative emission test procedures, longer vehicle usefull life definition, a new vehicle running loss emission standard and test procedure.
Compliance Assurance Program (CAP 2000)	California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles, CAP 2000 Impact on Enhanced Evap	CAP 2000 rule streamlines vehicle certification procedures and requires manufacturer funded "in-use" vehicle testing for evaporative emissions.
LEV II	California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles	LEV II significantly lowers evaporative emission standards from "enhanced evaporative" standards and increases the useful life definition.
Onboard Refueling Vapor Recovery (ORVR)	California Refueling Emission Standards and Test Procedures for 1998 and Subsequent Model Motor Vehicles/California Code of Regulations section 1978	This rule implements new vehicle standards and test procedures for the control of emissions during refueling
SFTP – Supplemental Federal Test Procedures	CCR Section 1960.1	The Supplemental Federal Test Procedure (SFTP) regulations add on to the current Environmental Protection Agency's Federal Test Procedure (FTP). SFTP contains two new drive cycles (a high speed and high load - US06 cycle and air conditioning on cycle - SC03) and standards. The Federal EPA and California regulations are intertwined with each other as well as the Federal National Low Emission Vehicle regulation (NLEV).
California On-Board Diagnostics II (OBD II) & Service Information	Sec.1968.2	Manufacturers are required to install an OBD system which monitors various exhaust and evaporative emission control components for malfunction or deterioration resulting in exceeding various emission thresholds and illuminates a malfunction indicator light (MIL).
California Environmental Performance Label Specification	Title 13, California Code of Regulations, Section 1965	The content of the label is specified in detail in the California regulations, including that the label must have a green border, and a smog score and global warming score printed in black type.
CARB LEV II Exh. Em.	Title 13, Division 3, Chapter 1, Section 1961	CARB requirements for PC, LDT and MDV exhaust emissions
CARB Zero Em.	Title 13, Division 3, Chapter 1, Section 1962	CARB requirements for PC and LDV exhaust & evaporative emissions, emissions warranty and advanced technology vehicles
California Low Carbon fuel Standard Regulation	Draft	LCFS applies to all California transportation fuels. Starting January 1, 2010 the carbon intensity standard should be reduced by 10% by 2020.

3.1.2.3. GREENHOUSE GASES AND CAFE

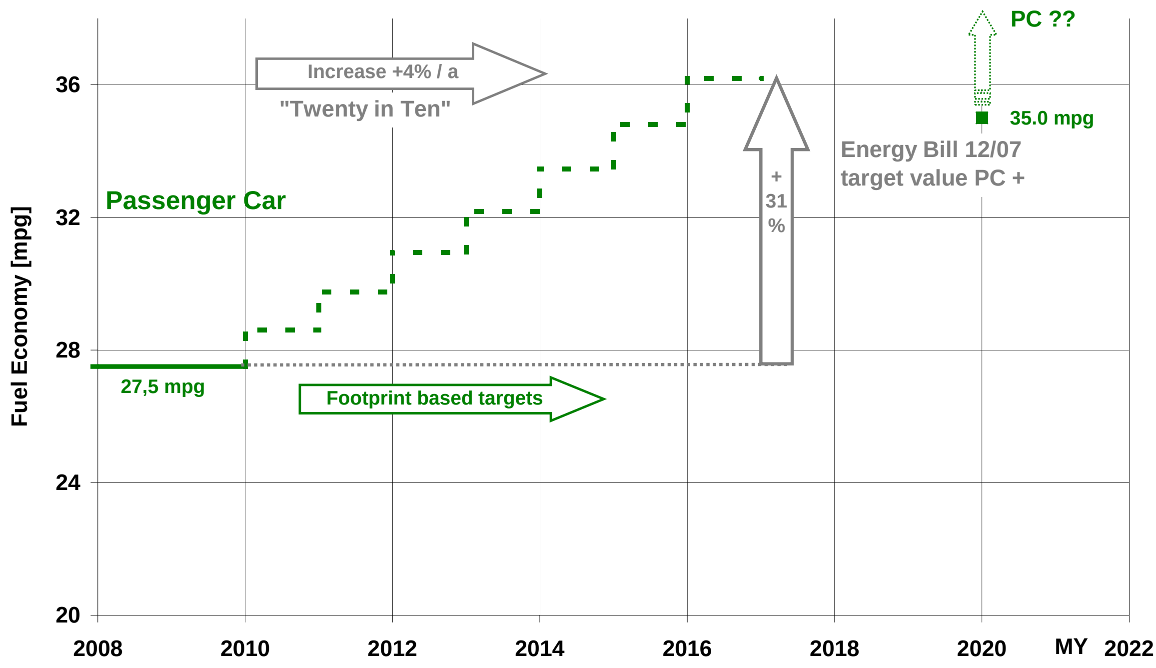


Fig. 3.1.2.3-1: CAFE (US - 50 States) „20in10“ and Energy Bill, Passenger Cars.

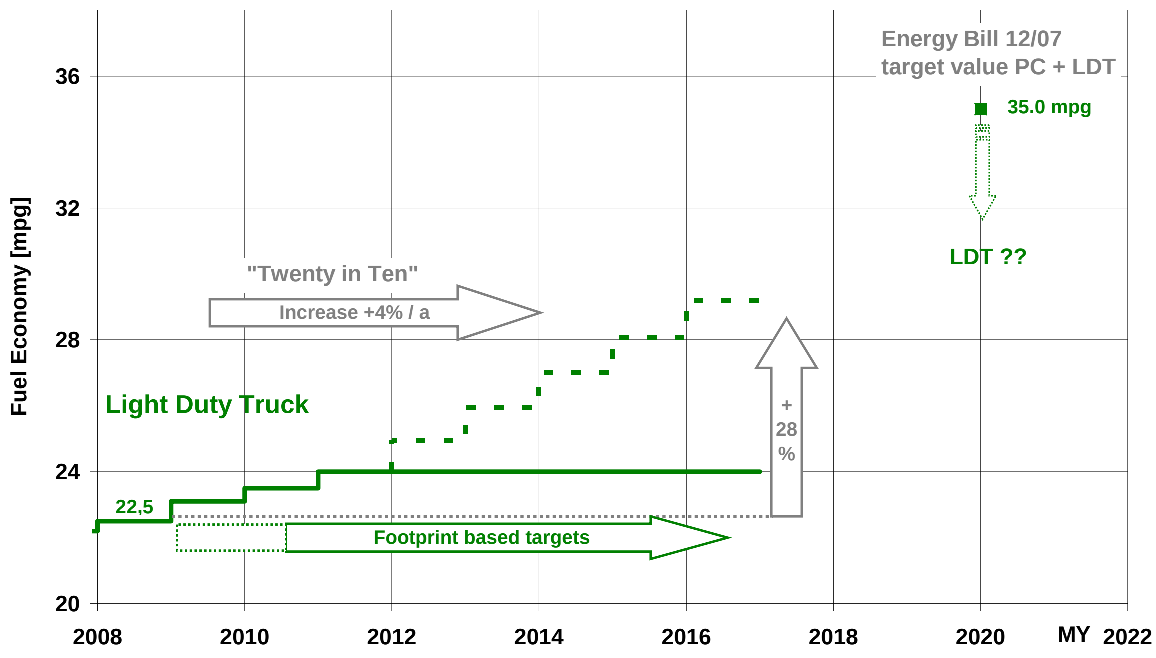


Fig. 3.1.2.3-2: CAFE (US - 50 States) „20in10“ and Energy Bill, Light Duty Trucks.

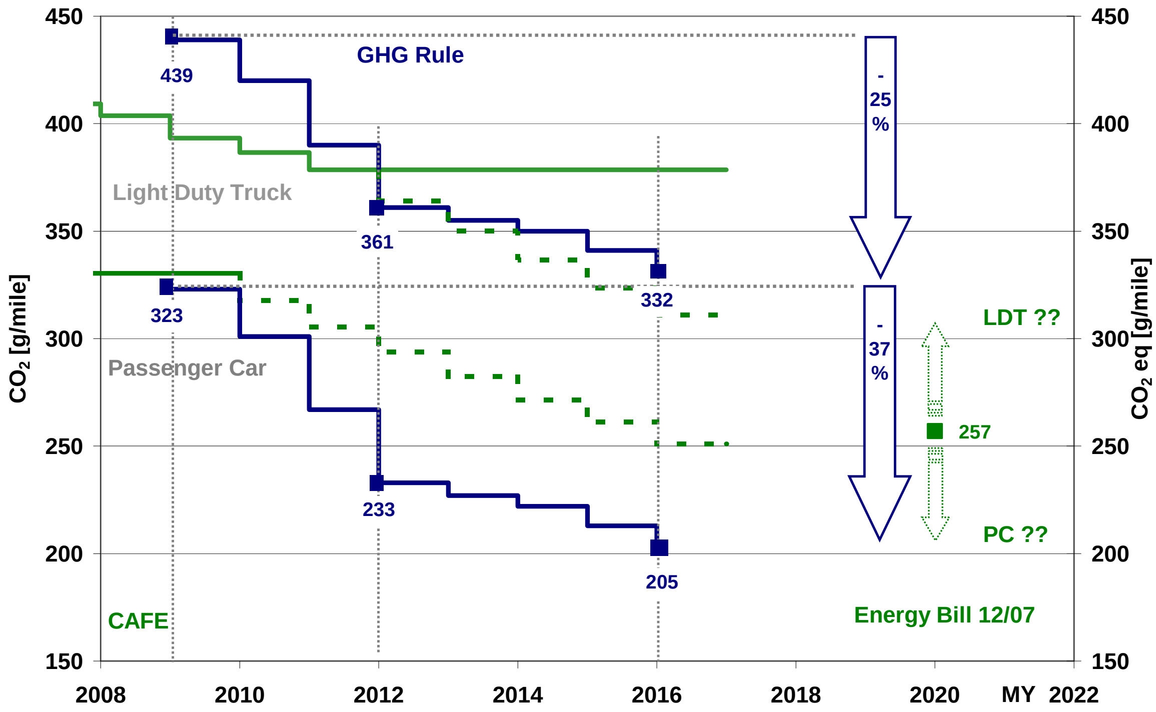


Fig. 3.1.2.3-3: GHG Rule (Cal + and Sect. 177 States) and CAFE (US – 50 States).

Tab. 3.1.2.3-1: Fleet average GHG emission standards.

Tier	MY	PC/LDT1 g mile^{-1}	LDT2/MDPV g mile^{-1}
Near-Term	2009	323	439
	2010	301	420
	2011	267	390
	2012	233	361
Mid-Term	2013	227	355
	2014	222	350
	2015	213	341
	2016	205	332

3.1.2.4. MERCURY LAW

Key Provisions of L.D. 1921; Signed into law on 10 April, 2002

1. Prohibits the use of mercury switches in all vehicles manufactured on or after 1 January, 2003;

2. Requires vehicle manufacturers to establish a system for the removal and collection of the mercury-containing parts in old cars before they are scrapped.

   - Vehicle Manufacturers are required to establish and maintain authorized "consolidation" facilities geographically located to serve all areas of the state by 1 January, 2003;

- New and used car dealerships are not authorized to participate in the system;

- Manufacturers are required to pay a minimum of $1 per switch brought to the consolidation facilities;

3. Vehicles that contain mercury that apply to vehicles built on or after July 15, 2002 must have a label on the driver-side doorpost specifying which components in the vehicle may contain mercury.

4. New manufacturer reporting requirements:

   - Before 1 January, 2003, vehicle manufacturers are required to submit information if they intend to levy a fee on new vehicles sold in the state, including the amount charged to customers, and the basis for charging said amount;

   - By July 1, 2004, vehicle manufacturers are required to report on the number of mercury switches removed and recycled through the consolidation facilities;

3.1.3. CHINA

3.1.3.1. CHINA ENVIRONMENTAL REGULATIONS

China - Environmental Regulations				
	Regulation China nationwide	**Regulation China special areas**	**Reference**	**Comment**
CO_2/ fuel consumption standards	Fuel consumption standards applied to M1 vehicles with GVM not more than 3500kg. 2 sets of fuel consumption limits for different M1 models: 1. Normal M1 (with MT and excluding the following models), 2. Special M1 (automatic transmission (AT), or 3 or more rows of seats or off-road vehicles); 2-phase implementation: Phase-1 started 07/2005 for new approval car models and 07/2006 for in-production car models, Phase-2 started 01/2008 for new approval car models and starting 01/2009 for in-production car models. The authorities are planning to issue Phase Ⅲ fuel limit in 2011 and to initiate framing in the year end.		Important Technical Standards & Legislations in China Auto Industry; Volkswagen Group China; Issue: Aug. 2008 China Automotive Technologie News; Volkswagen Group China; Issue No. 59, August 2008; Technical Development Division (Source: CATARC)	Regulation Name: Limits of fuel consumption for light duty commercial vehicles Regulation Number: GB 20997-2007

China - Environmental Regulations				
	Regulation China nationwide	**Regulation China special areas**	**Reference**	**Comment**
Emission control	From July 1st of 2007, the car models for new type approval must be EU 3 (without OBD) and from July 1st of 2010, the new approval car models should be EU 4. The Chinese authorities are considering to draft the national standard similar or equivalent to EU 5/ EU 6 after the official publication of EU 5/ EU 6 in Europe.	Beijing has implemented EU 4 for gasoline passenger cars since March 1st of 2008. For this implementation, Beijing Municipal Government implemented its local fuel standards of EU 4 for both gasoline & diesel fuels since January 1st of 2008. Shanghai and Pearl River Delta (Guangzhou/Shenzhen) are planning to implement EU 4 for both gasoline and diesel cars in the second half of 2009 or at the beginning of 2010.	Important Technical Standards & Legislations in China Auto Industry; Volkswagen Group China; Issue: Aug. 2008	Regulation Name: Limits Measurement Methods for Emissions From Light-Duty Vehicles (II and IV) Regulation Number: GB18352.3-2005
Diesel Emissions		Because of the local air pollution problems, some special local areas beside Beijing, including Guangzhou/Shenzhen, will adopt more stringent regulations for diesel vehicles, especially more strict requirements for the particulate emissions.	Important Technical Standards & Legislations in China Auto Industry; Volkswagen Group China; Issue: Aug. 2008	
OBD Requirements	From July 1st of 2008, the OBD system will be requested on the new approval gasoline car models and from July 1st of 2009, the OBD system will be requested on all the gasoline cars registered nationwide; From July 1st of 2010, the OBD system will be requested on the new approval diesel car models and from July 1st of 2011, the OBD system will be requested on all the diesel cars registered nationwide.	Chendu started to request the OBD on the EU 3 cars from May 1st of 2008, which was one year earlier than the nationwide implementation plan.	Important Technical Standards & Legislations in China Auto Industry; Volkswagen Group China; Issue: Aug. 2008	Regulation Name: Limits Measurement Methods for Emissions From Light-Duty Vehicles (II and IV) Regulation Number: GB18352.3-2005

China - Environmental Regulations				
	Regulation China nationwide	Regulation China special areas	Reference	Comment
Vehicle Consumption Tax	The existing consumption taxation system for passenger vehicles has been in effective since April of 2006. A new policy takes effect on Sept 1, 2008. The consumption tax rate for passenger vehicles with engine displacement ranging from 3.0 L to 4.0 will be increased to 25 percent from the current 15 percent, and the tax rate for those with over 4.0 L displacement will be up to 40 percent from the current 20 percent. Contrarily, passenger cars with 1.0 or less displacement range will pay 1 percent of the consumption tax instead of 3 percent.		China Automotive Technologie News; Volkswagen Group China; Issue No. 59, August 2008; Technical Development Division (Source: MOF.gov, Aug. 13, 2008)	
Exterior Noise	The standard is formulated as per the Law of the People's Republic of China on the Prevention and Control of Environmental Noise Pollution. It is formulated in reference to the regulation of Uniform Provisions Concerning the Approval of Motor Vehicles. Having at Least Four Wheels with Regard to Their Noise Emission (ECE Reg.No.51) of the Economic Commission for Europe of the United Nations (UN/ECE) and based on the actual conditions of motor vehicle products in China.		Ministry of Environmental Protection People's Republic of China	Regulation Name: Limits and measurement methods for noise emitted by accelerating motor vehicles Regulation Number: GB 1495-2002
Recycling and Recovery of End-of-Life Vehicles (ELV)	This Standard specifies a method for calculating the recyclability rate and the recoverability rate of a new road vehicle, each expressed as a percentage by mass (mass fraction in percent) of the road vehicle, which can potentially be - recycled, reused or both (recyclability rate), or - recovered, reused or both (recoverability rate). The calculation is performed by the vehicle manufacturer when a new vehicle is put on the market.		ISO 22628:2002	Regulation Name: Road vehicles Recyclability and recoverability — Calculation method Regulation Number: GB/T 19515-2004/ISO22628:2002

3.1.3.2. EXHAUST GAS EMISSION

Emission control – EU 3/4 nationwide

- national standard GB18352.3-2005 based on 2003/76/EC,
- published by State Environmental Protection Administration (SEPA, now Ministry of Environmental Protection, MEP) on April 15th of 2005,
- following implementation plan was stated:

  - From July 1st of 2007, the car models for new type approval must be EU 3 (without OBD) and from July 1st of 2010, the new approval car models should be EU 4;
  - From July 1st of 2008, the OBD system will be requested on the new approval gasoline car models and from July 1st of 2009, the OBD system will be requested on all the gasoline cars registered nationwide;
  - From July 1st of 2010, the OBD system will be requested on the new approval diesel car models and from July 1st of 2011, the OBD system will be requested on all the diesel cars registered nationwide.

Fig. 3.1.3.2-1: Emission control for petrol passenger cars – overview and perspective.

Fig. 3.1.3.2-2: Emission control for diesel passenger cars – overview and perspective.

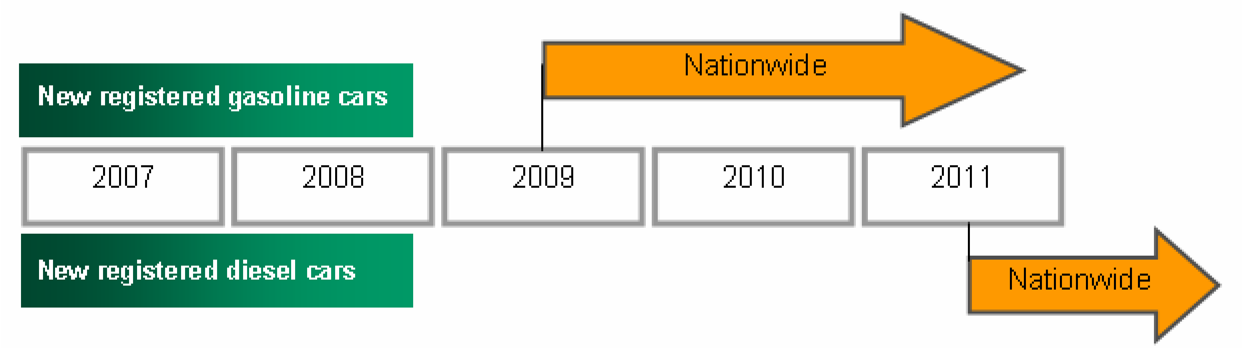


Fig. 3.1.3.2-3: OBD implementation plan China-wide.

Emission control – other specific issues

- Beijing has implemented EU 4 for gasoline passenger cars since March 1st of 2008. For this implementation, Beijing Municipal Government implemented its local fuel standards of EU 4 for both gasoline & diesel fuels since January 1st of 2008.

- In Chengdu, all the new registered Category 1 light vehicles (refer to the passenger cars with GVM not more than 2500 kg / seats not more than 6) must be EU 3 and equipped OBD since May 1st of 2008. This movement shows that more and more local areas will have the advancing implementation of the national standards.

- Because of the local air pollution problems, some special local areas beside Beijing, including Guangzhou/Shenzhen, will adopt more stringent regulations for diesel vehicles, especially more strict requirements for the particulate emissions.

- China authority is planning to draft EU 5/6 standards. Some car makers, e.g. GM China, already officially announced their development of EU 5 cars for the Chinese market.

Driving Cycles:

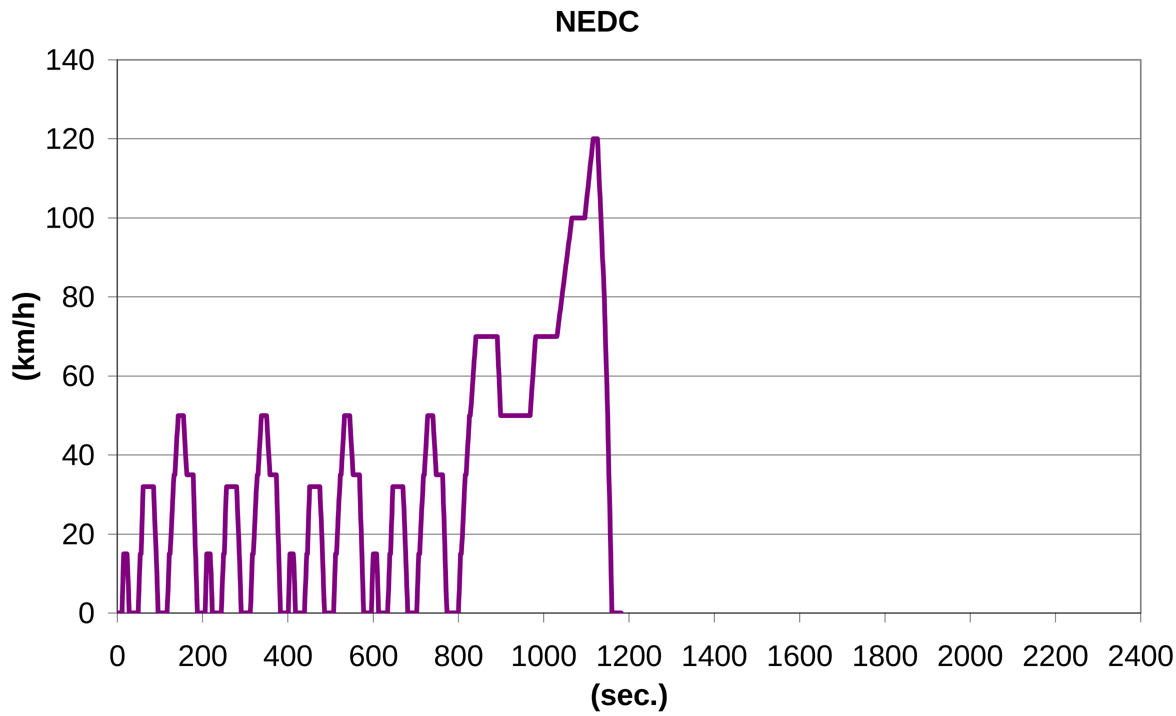


Fig. 3.1.3.2-4: NEDC 2000.

Tab. 3.1.3.2-1: Driving cycle summary.

Time	1180 s
Distance	11007 m
Max. Speed	120 km/h
Ave. Speed	33.6 km/h
Soak	N/A
Gear shift (man)	Fixed speeds

3.1.3.3. FUEL CONSUMPTION STANDARDS FOR PASSENGER CARS

- Standards applied to M1 vehicles with GVM not more than 3500kg

- 2 sets of fuel consumption limits for different M1 models:

  - Normal M1 (with MT and excluding the following models)
  - Special M1 (automatic transmission (AT) or 3 or more rows of seats or off-road vehicles)

- 2-phase implementation: Phase-1 Phase-2

	Phase-1	Phase-2
2-phase implementation:	Phase-1	Phase-2
new approval car models	07/2005	01/2008
in-production car models	07/2006	01/2009

- The working group on phase-3 fuel consumption limits was established already. The draft limits are expected to be finished by the end of 2009.

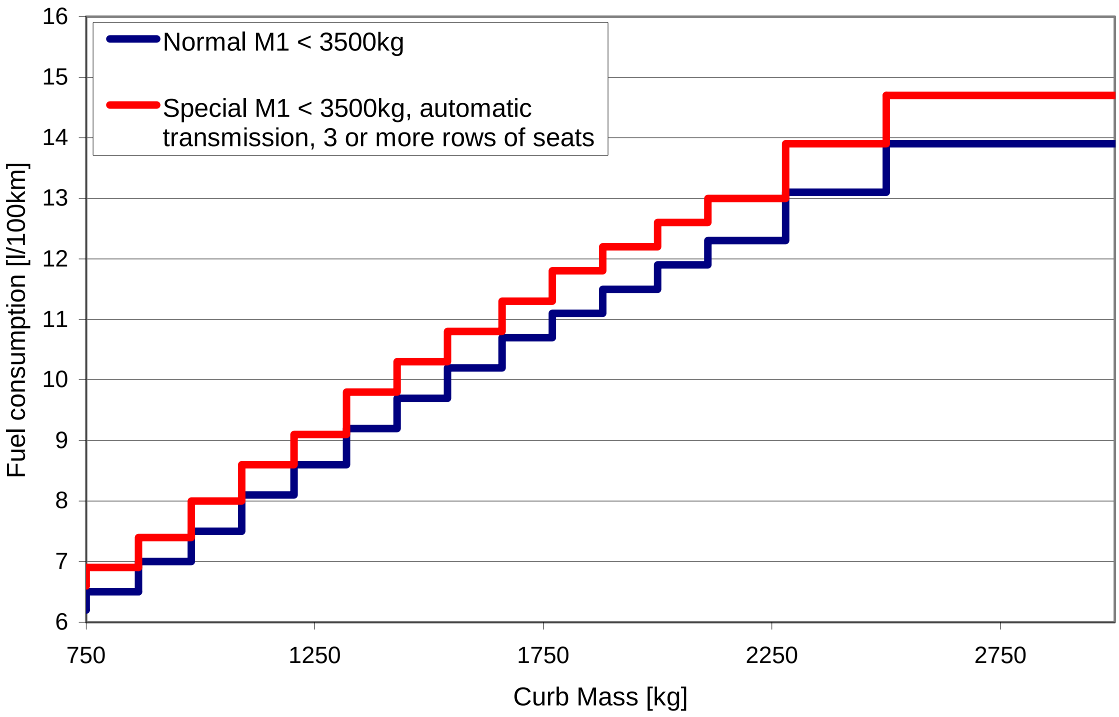


Fig. 3.1.3.3-1: Standard – Fuel consumption Phase-2 limits.

3.1.3.4. RECYCLING AND RECOVERY OF END-OF-LIFE VEHICLES (ELV)

Topics of the phase-3 research project by NDRC/CATARC:

The project is divided into three parts, which are related to management methods, banned / restricted materials and material database. The relevant working groups have been established accordingly.

- Researches on the development of the "Administrative Rules on RRR Rates of Automotive Products and Banned/Restricted Materials" and the relevant calculation methods;
- Survey / study on the banned/restricted materials in China auto industry;
- Basic researches and data collection related to China Automotive Materials Data System (CAMDS).

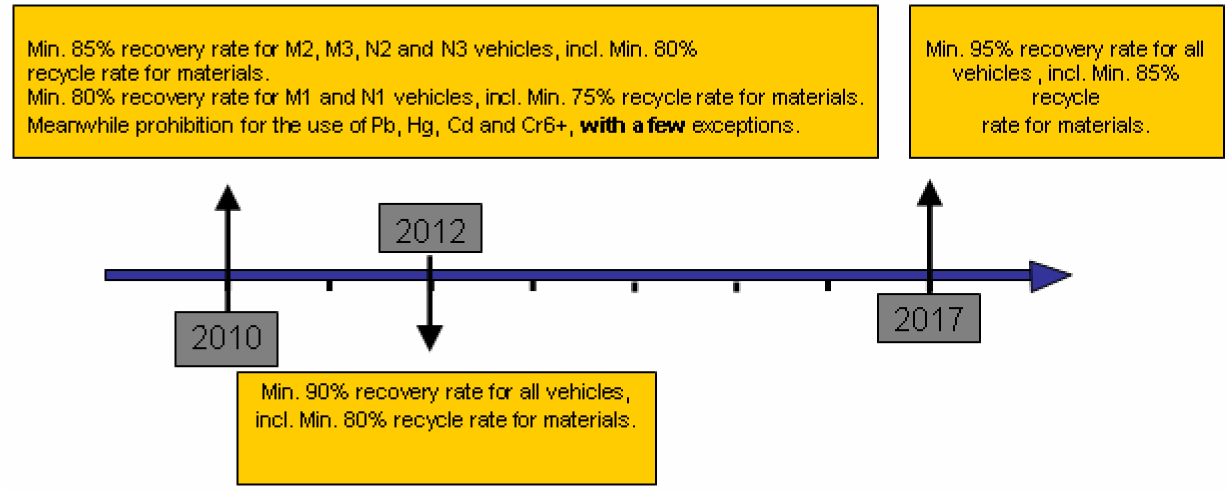


Fig. 3.1.3.4-1: 3-phase research projects.

3.1.3.5. CHINA GREEN VEHICLE

The "Green Vehicle"certificates are based on a set of requirements. All four certificates include the evaluation factors "Emission control (OBD)" and "Fuel consumption".
Additionally they include at least one of the following criteria:

- CO_2 emission
- Curb mass
- Exterior and interior noise
- inner vehicle air quality
- ELV RRR rates, Banned materials, EMI, non-CFC materials in AC system, non-asbestos material, max. vehicle speed, acceleration and climbing ability

Often References to GB / GB/Ts given.

There would be four kinds of such certification in China:

1. "Green Vehicle" Certification by China National Accreditation and Certification Committee (CNCA). The relevant rule has been implemented from 01.09.2006; from Guangzhou Toyota has been certified;

2. "Green Vehicle" Certification by National Technical Committee for Environment Management, Standardization Administration of China (SAC). The relevant national standard is under approval;

3. "Green Vehicle" Certification by Science & Technology and Standardization Department, State Environment Protection Administration (SEPA). The relevant rule has been implemented at the end of 2005; the so-called Green Vehicles have the priorities for "government purchasing" from 07.2007. The car models from FAW-VW and SVW were in the Group Procurement List jointly published by SEPA and the Ministry of Finance (MOF).

4. "Green Vehicle" Certification by Pollution Control Department, the State Environment Protection Administration (SEPA). The relevant rule is under discussion.

3.1.3.6. NOISE

The standard is formulated as per the Law of the People's Republic of China on the Prevention and Control of Environmental Noise Pollution. It is formulated in reference to the regulation of Uniform Provisions Concerning the Approval of Motor Vehicles Having at Least Four Wheels with Regard to Their Noise Emission (ECE Reg.No.51) of the Economic Commission for Europe of the United Nations (UN/ECE) and based on the actual conditions of motor vehicle products in China. The noise limit for vehicle in the standard is to replace that set down in the standard GB 1495-79. The noise measurement method of the standard is in reference to the Annex 3 of the Uniform Provisions Concerning the Approval of Motor Vehicles Having at Least Four Wheels with Regard to Their Noise Emission (ECE Reg.No.51/02) (1997) of the UN/ECE as well as related content of the international standard of Acoustics - Measurement of Noise Emitted by Accelerating Road Vehicles - Engineering Method (ISO362: 1998) in its technical content. The related requirements on the road surface for noise test of the standard adopt that of the stipulation in the Provisions of the Requirements of Road Surface for the Test of Noise Emitted by Road Vehicles (ISO10844: 1994) and was put into effect as of January 1, 2005. The standard is implemented in two different time periods according to the date of manufacture of the vehicle.

3.1.4. EU & UN-ECE

3.1.4.1. UN-ECE AND EUROPEAN ENVIRONMENTAL REGULATIONS

	UN-ECE Environmental Regulations		European Regulations	
Regulation	Reference	Comment	Reference	Comment
			Airquality: 2008/50/EC on ambient air quality and cleaner air for Europe	Regulations of ambient air quality in relation to sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate Matter (PM_{10}, $PM_{2,5}$), lead, benzene, carbon monoxide and ozone
Regulated pollutants – roller bench type approval				
Emissions of pollutants according to engine fuel requirements	ECE R 83-05	Scope: vehicles M1, N1 with MTALW ≤ 3,5 t	Euro 5 & 6: 715/CE/2007 et 692/2008/CE	Scope: vehicles M1, M2, N1, N2 with reference mass ≤ 2610 kg (derogation possible until 2840 kg under specific conditions)
	supplement 1 to 6	- provisions for OBD; emission test procedure for periodically regeneration exhaust aftertreatment systems; provisions for Hybrid vehicles type approval; provisions for gaseous LPG/NG vehicles		implementation measure based on ECE R 83-05 except some specific requirements (limit values; deterioration factors; durability test procedure; emission at low T°C in Diesel; OBD; access to vehicle repair and maintenance information; use of reagent fort he exhaust aftertreatment system; flexfuels vehicle…)

	UN-ECE Environmental Regulations		European Regulations	
Regulation	Reference	Comment	Reference	Comment
	ongoing supplement 7	- provisions for modified particulate mass measurement procedures; - provisions for particle number measurement procedures		
Smoke (Diesel only)	ECE R 24-03	Scope: all Diesel vehicles	Euro 5 & 6: 715/CE/2007 et 692/2008/CE	Scope: vehicles M1, M2, N1, N2 with reference mass ≤ 2610 kg (derogation possible until 2840 kg under specific conditions) implementation measure based on ECE R 24-03 except some specific requirements
Consumption and CO_2 measurement	ECE R 101 supplement 6	Scope: vehicles M1 (internal combustion engine and hybrid electric powertrain) and vehicles M1 & N1 powered by an electric powertrain the driving cycle is the one described in the UN ECE R38 (NM VEG cycle); regenerating system taken into account	Euro 5 & 6: 715/CE/2007 et 692/2008/CE	Scope: vehicles M1, M2, N1, N2 with reference mass ≤ 2610 kg (derogation possible until 2840 kg under specific conditions) - roller bench type approval implementation measure based on ECE R 101 except some specific requirements and scopes (flexfuels vehicles;…)
CO_2 regulation	nothing up to now		European project on going	Scope announced: M1 and N1 later on
ELV & recyclability End of Life Vehicles Recyclability, recovery & reuse Heavy metals	 nothing up to now		 2000/53CE 2005/64/CE Decision 2008/689/CE	 Heavy metals derogations; annex II of ELV directive
Noise	ECE R51.02	revision R51.03 towards 2013 (estimation)	2007/34/CE	

3.1.4.2. EXHAUST GAS EMISSION

Tab. 3.1.4.2-1: Euro 3 and 4 Emission Limits.

			Reference mass (RW) (kg)	Limit values: Mass of carbon monoxide (CO)		Mass of hydrocarbons (HC)		Mass of oxides of nitrogen (NO_x)		Mass of particulates[1] (PM)
				L_1 (g/km)		L_2 (g/km)		L_3 (g/km)		L_4 (g/km)
Category		Class		Petrol	Diesel	Petrol	Diesel	Petrol	Diesel	Diesel
Euro 3	M [2]	-	All	2,3	0,64	0,20	-	0,15	0,50	0,05
	N_1 [3]	I	RW ≤ 1305	2,3	0,64	0,20	-	0,15	0,50	0,05
		II	1305 < RW ≤ 1760	4,17	0,80	0,25	-	0,18	0,65	0,07
		III	1760 < RW	5,22	0,95	0,29	-	0,21	0,78	0,10
Euro 4	M [2]	-	All	1,0	0,50	0,10	-	0,08	0,25	0,025
	N_1 [3]	I	RW ≤ 1305	1,0	0,50	0,10	-	0,08	0,25	0,025
		II	1305 < RW ≤ 1760	1,81	0,63	0,13	-	0,10	0,33	0,04
		III	1760 < RW	2,27	0,74	0,16	-	0,11	0,39	0,06

(1) For compression ignition engines.
(2) Except vehicles the maximum mass of which exceeds 2 500 kg.
(3) And those Category M vehicles which are specified in note 2.'

Tab. 3.1.4.2-2: Euro 5 Emission Limits.

		Reference mass (RM) (kg)	Limit values: Mass of carbon monoxide (CO)		Mass of total hydrocarbons (THC)		Mass of non-methane hydrocarbons (NMHC)		Mass of oxides of nitrogen (NO_x)		Mass of particulate matter [1] (PM)		Number of particles [2] (P)	
			L_1 (mg/km)		L_2 (mg/km)		L_3 (mg/km)		L_4 (mg/km)		L_5 (mg/km)		L_6 (#/kg)	
Category	Class		PI	CI	PI	CI	PI	CI	PI	CI	PI[3]	CI	PI	CI
M	-	All	1000	500	100	-	68	-	60	180	5,0/4,5	5,0/4,5	-	$6x10^{11}$
N_1	I	RM ≤ 1305	1000	500	100	-	68	-	60	180	5,0/4,5	5,0/4,5	-	$6x10^{11}$
	II	1305 < RM ≤ 1760	1810	630	130	-	90	-	75	235	5,0/4,5	5,0/4,5	-	$6x10^{11}$
	III	1760 < RM	2270	740	160	-	108	-	82	280	5,0/4,5	5,0/4,5	-	$6x10^{11}$
N_2	-	All	2270	740	160	-	108	-	82	280	5,0/4,5	5,0/4,5	-	$6x10^{11}$

Key: PI = Positive Ignition, CI = Compression Ignition
(1) A revised measurement procedure shall be introduced before the application of the 4,5 mg/km limit value.
(2) A new measurement procedure shall be introduced before the application of the limit value.
(3) Positive ignition particulate mass standards shall apply only to vehicles with direct injection engines

Tab. 3.1.4.2-3: Euro 6 Emission Limits.

		Reference mass (RM) (kg)	Limit values											
			Mass of carbon monoxide (CO)		Mass of total hydrocarbons (THC)		Mass of non-methane hydrocarbons (NMHC)		Mass of oxides of nitrogen (NO_x)		Mass of particulate matter [1](PM)		Number of particles [2] (P)	
			L_1 (mg/km)		L_2 (mg/km)		L_3 (mg/km)		L_4 (mg/km)		L_5 (mg/km)		L_6 (#/kg)	
Category	Class		PI	CI	PI	CI	PI	CI	PI	CI	PI[3]	CI	PI[4]	CI[5]
M	-	All	1000	500	100	-	68	-	60	80	5,0/4,5	5,0/4,5	-	$6x10^{11}$
N_1	I	RM ≤ 1305	1000	500	100	-	68	-	60	80	5,0/4,5	5,0/4,5	-	$6x10^{11}$
	II	1305 < RM ≤ 1760	1810	630	130	-	90	-	75	105	5,0/4,5	5,0/4,5	-	$6x10^{11}$
	III	1760 < RM	2270	740	160	-	108	-	82	125	5,0/4,5	5,0/4,5	-	$6x10^{11}$
N_2	-	All	2270	740	160	-	108	-	82	125	5,0/4,5	5,0/4,5	-	$6x10^{11}$

Key: PI = Positive Ignition, CI = Compression Ignition
(1) A revised measurement procedure shall be introduced before the application of the 4,5 mg/km limit value.
(2) A number standard is to be defined for this stage for positive ignition vehicles.
(3) Positive ignition particulate mass standards shall apply only to vehicles with direct injection engines.
(4) A number standard shall be defined before 1 September 2014.'
(5) A new measurement procedure shall be introduced before the application of the limit value.

Driving Cycles:

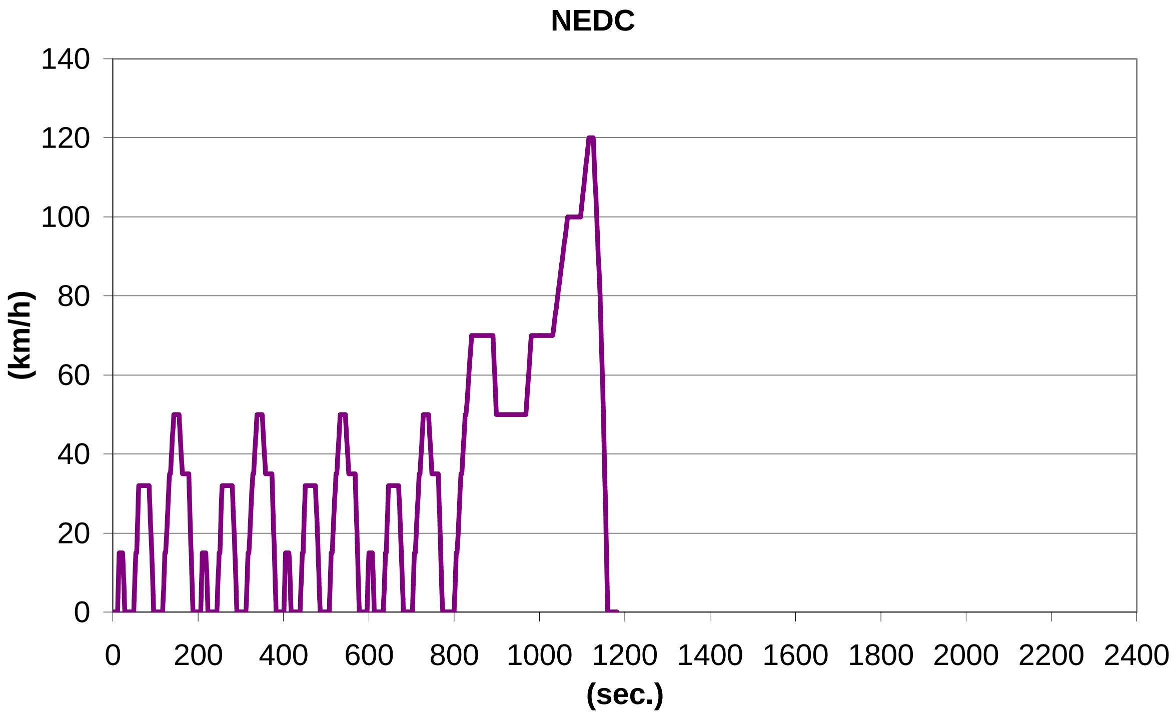


Fig. 3.1.4.2-1: Driving cycle for European Union (NEDC 2000).

Tab. 3.1.4.2-4: Driving cycle summary.

Time	1180 s
Distance	11007 m
Max. Speed	120 km/h
Ave. Speed	33.6 km/h
Soak	N/A
Gear shift (man)	Fixed speeds

3.1.4.3. CO_2 –EUROPEAN REGULATION

The objective of the regulation is to reach 120 g/km in 2015, as an average for the whole passenger car fleet (new vehicles), starting in 2012 (phase-in). This goal is splitted in 130 g/km based on type approval of M1 vehicles (by means of improvements in vehicle motor technology) and 10 g/km related to the complementary measures (GSI; TPMS; LRRT; MAC system efficiency; biofuels).
Each car manufacturer has to comply with an objective according to the CO_2 function defined as follows: CO_2 = 130 + ax (M - M0), compared to the actual average emissions from new cars sold in the EU-27. (NB : M = mass in running order ; a = 0,0457; M0 = 1372kg).
The phase-in is defined as follows: 65% in 2012; 75% in 2013; 80 % in 2014; 100% in 2015, using proportions of new passenger cars registered in each year.
New passenger cars with specific CO_2 emissions of less than 50 g/km count as 3,5 cars in 2012 and 2013, as 2,5 cars in 2014, as 1,5 cars in 2015 and 1 car from 2016 onwards. The regulation includes also special rules for cars using E 85.
Eco-innovation technology will be taken into account in the limitation of 7g/km by car manufacturer, provided the contribution to the CO_2 reduction is not taken into account by the type approval procedure.
In the case of non conformity penalties have to be paid.
The 2020 target is 95 g/km, depending on an impact assessment, planned for 2013, e.g. to reconsider the key parameter (footprint versus mass ?).

< Fig. expected >

Fig. 3.1.4.3-1: Correlation vehicle weight - CO_2 for year 2006.

3.1.4.4. CO_2 LABELLING DIRECTIVE

< further input expected >

3.1.4.5. FUEL REGULATIONS

< further input expected >

3.1.4.6. NOISE

Preliminary: there are several noise sources which contribute to noise pollution. One of those comes from the vehicles explaining regulation on vehicle external noise.

References:
- European Regulation: 70/157 * 2007/34/CE
- UN-ECE regulation as an equivalence: ECE R51-02

Summary of the requirements:
According to both stationary and rolling test procedures, the level of the external noise of vehicles is checked.
For the purpose of M1 and N1 vehicle categories, the mandatory limit values are currently:

- Category M1: 74 dB(A)
  (with a derogation for compression ignition engines and direct injection engines: 75 dB(A))

- Category N1: 76 dB(A) if the MTALW≤ 2t and 77 dB(A) in other cases.
  (MTALW = Maximum Technically Admissible Laden Weight)

Next step:
A new test procedure have been defined in order to better evaluate the noise behaviour in urban conditions.
So, based on this procedure and in parallel with the current one, a monitoring phasis is ongoing in order to allow decision makers to define new limits.

3.1.4.7. RECYCLING

References :
- European Regulation: End of Life Vehicles (ELVs) Directive 2000/53/CE
  Recyclability, Recovery and Reuse (RRR) 2005/64/CE
- UN-ECE regulation: no equivalence

Summary of the requirements:

* 2000/53/CE:
The main purpose is to constrain the European Members states to improve the recycling and the recovery of their ELVs, starting with an objective of a minimum threshold to achieve for both:
- recycling: 80 % in 2006 and 85 % in 2015
- recovery: 85 % in 2006 and 95 % in 2015

First results have been published in 2008 as follow:

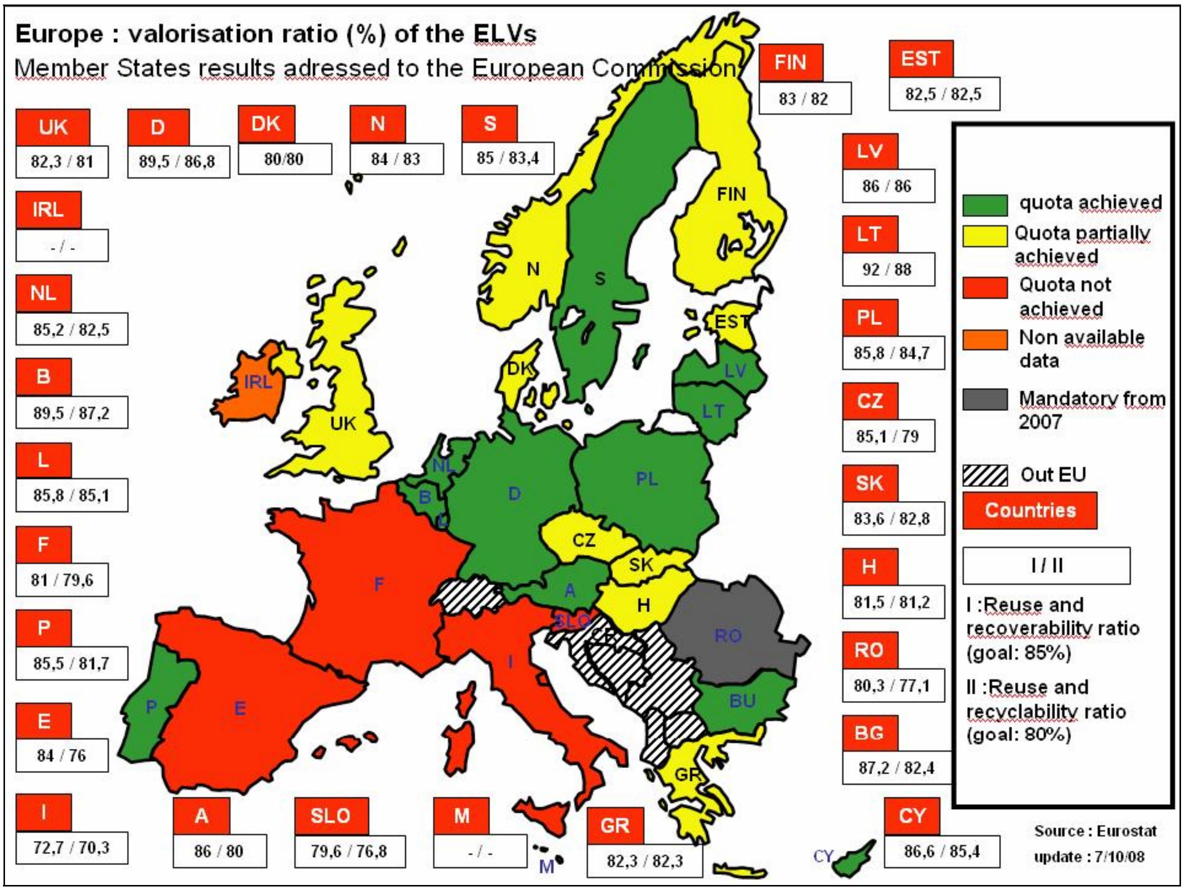


Fig. 3.1.4.7-1: Valorisation Ration of the ELVs.

* 2005/64/CE
To contribute to the above targets, the main purpose of the RRR Directive is to constrain the Cars manufacturers to improve the recyclability and the recoverability of their vehicles, starting with an objective at the type approval of a minimum threshold to achieve for both:
- recyclability: 85 %
- recoverability: 95 %
from 15/12/2008 for New Types and from 15/07/2010 for all types.

The process established by the car manufacturer in terms of:
- Recommended strategy for recycling and recovery,
- Collection and traceability of the relevant data (weights of the components, chemical nature of the materials),
- Calculation of the ratio according to ISO 22628.
- Compliance with the heavy metals ban (Lead, Mercury, Cadmium, ChromiumVI) , except for certain applications under derogation

is evaluated by the type approval authorities each two years.

3.1.4.8 'GREEN PUBLIC PROCUREMENT' DIRECTIVE

On 22nd Oct 2008, The European Parliament backed the first reading agreement with the Council regarding the Directive 'On the promotion of clean and energy efficient road transport vehicles'. 18 months after publication, the directive shall be transposed into national laws. The directive

requires contracting entities (public authorities) to take into account also criteria addressing operational CO_2, NO_x, NMHC, and PM emissions, and operational ‚energy consumption' when purchasing road transport vehicles. Contracting authorities can consider including other environmental impacts.

Member States can do this by

1. setting technical specifications for energy and environmental performance (e.g. a certain minimum emission standard)
2. or by including energy and environmental impacts in the purchasing decision, whereby:
    a. in cases where a procurement procedure is applied, this shall be done by using these impacts as award criteria (e.g. maximum CO_2 emissions)
    b. in cases where these impacts are monetised, a proposed calculation methodology shall be applied (internalisation of external costs).

In case of 2b, the lifetime cost for the operation of a vehicle shall be calculated by:

- determining operational lifetime fuel consumption, and converting it into ‚energy consumption', based on values proposed in the legislation (table 3.1.4.8-1)
- determining operational lifetime CO_2 emissions and emissions of NO_x, NMHC, and PM
- determining emissions based on standardised EU test procedures for the vehicles for which such test procedures are defined in EU type approval legislation. For vehicles not covered by standardised EU test procedures, comparability between different offers shall be ensured by using widely recognised test procedures, or the results of tests for the authority, or information supplied by the manufacturer.
- Converting operational lifetime energy consumption, CO_2 emissions and emissions of NO_x, NMHC and PM, into ‚costs' based data provided by the legislation (table 3.1.4.8-2)
- using lifetime mileages defined in the legislation, if not otherwise specified (table 3.1.4.8-3)

Tab. 3.1.4.8-1: Energy content of motor fuels.

Fuel	**Energy content**
Diesel	36 MJ/litre
Petrol	32 MJ/litre
Natural Gas/Biogas	***33*** - 38 MJ/Nm^3
LPG (liquefied petroleum gas)	24 MJ/litre
Ethanol	21 MJ/litre
Biodiesel	33 MJ/litre
Emulsion fuel	32 MJ/litre
Hydrogen	11 MJ/Nm^3

Tab. 3.1.4.8-2: Cost for emissions in road transport (in 2007 prices).

CO_2	**NO_x**	**NMHC**	**Particulate Matter**
3-4 €cents/kg	0.44 €cents/g	0.1 €cents/g	8.7 €cents/g

Tab. 3.1.4.8-3: Lifetime mileage of road transport vehicles.

Vehicle category (M and N categories as defined in Directive 2007/46/EC)	**Lifetime mileage**
Passenger cars (M1)	200 000 km
Light commercial vehicles (N1)	250 000 km
Heavy goods vehicles (N2, N3)	1 000 000 km
Buses (M2, M3)	800 000 km

3.1.5. ENVIRONMENTAL LABEL SWITZERLAND

Development of an environmental rating label for cars [11]

In 2007, the Federal Department of the Environment, Transport, Energy and Communications (DETEC) decided to continue development of the energy rating label for cars, which assesses the energy efficiency of cars according to categories on a scale from A to G. An environmental label is to be developed from the current rating label, which, apart from the classification of cars into efficiency categories, also makes possible differentiation according to ecological and especially air quality criteria. It is planned to introduce the new environmental label on 1 January 2010.

The content of the existing energy label should be transferred to the future environmental label virtually without change, though complemented by additional information on the environmental impact of the vehicle. Included in the environmental rating are two assessments that are independent of one another. The energy efficiency is appraised according to the previous seven categories from A to G. The same number of vehicle models is now to be classified in each category. The energy section will be supplemented by an environmental section in the form of environmental impact points. These environmental impact points will appear on the environmental label in the form of figures and graphically, similar to what is currently the case on the energy label for CO_2 emissions. The environmental impact points derive from the criteria compiled by the Federal Office for the Environment (FOEN) for energy efficient and low-emission vehicles (Kriterien für energieeffiziente und emissionsarme Fahrzeuge (KeeF)). The calculation of environmental impact points includes emissions of NO_X, HC, PM_{10}, CO, CO_2, noise and fuel production.

Along with more comprehensive consumer and fuel consumption information, the future environmental label should also make it possible to take into consideration further environmental aspects in the ecological differentiation of Cantonal motor vehicle taxes and Federal car tax. The Commission for the Environment, Town and Country Planning and Communications of the Council of States UREK-S provided information on the main features of a bonus system in October 2008. With effect from today, car tax should be increased from 4 to 8%. The increased income should be used for the financial promotion of energy-efficient and environmentally-friendly vehicles. With this scheme, vehicles in energy efficiency category A should receive the energy efficiency bonus in full, whereas those in category B should receive 50%. It is also planned that vehicles below a certain number of environmental impact points will receive an environmental bonus. The relevant amendment to the Car Tax Act will be put out to consultation from November 2008.

The environmental label with its additional consumer information and the differences in car tax it supports should result in cars on Swiss roads which in future are more modern and resource-efficient, with less impact on the environment.

3.1.6. INDIA

3.1.6.1. INDIA ENVIRONMENTAL REGULATIONS

	Regulation	Reference	Comment
CO_2	Discussion ongoing. Proposals based on mass CO_2 target lines affective 2010. Less stringent targets compared to EU.		SIAM presentations
HC+No_x, Co Light Duty	From April 2005, India State emissions requirements based on European Stage II with the National Capitol Region (NCR) and other cities, mandating requirements based on European Stage III. Stage III applicable to India State from April 2010. Stage IV applies to the NCR and 11 cities from Apr 2010. Both India and NCR have adopted a modified test procedure with a limit of 90 kph.	CENTRAL MOTOR VEHICLES RULES, 1989 (EXTRACTS) Latest amendment Notification No. GSR 207(E) dated April 10, 2007	Regulation Name: INDIA EMISSIONS FORECAST - LIGHT DUTY
OBD Requirements	The Bharat Stage IV requirements are amended to mandate OBD. OBD is applied in 2 phases, with the OBD thresholds (identical to the European Stage III / IV thresholds) being applied at the second step. VEHICLES AFFECTED: All Light Duty Vehicles (M&N) GVM <= 3500kg	draft BS-IV, CMVR draft 2006	Regulation Name: Bharat Stage IV - proposed inclusion of OBD
Noise Requirements	Exterior noise requirements applicable from 1 Jan 2003, 1 July 2003 & 1 April 2005 manufacture.	G.S.R.849(E), Environment SI No 56 dated 30 December 2002	Regulation Name: EXTERIOR NOISE REQUIREMENTS
Type Approvel – CNG Vehicles	Revised requirements for conversion and retro-fitment of Compressed Natural Gas (CNG) systems. Applicable from 19 May 2002.		Regulation Name: TYPE APPROVAL OF CNG VEHICLES Regulation Number: NOTIFICATION NO.853(E) 19 NOV 2001
Exterior Noise	Drive-by & static noise, equivalent to 70/157/EEC as amended but includes electric vehicles.	UN ECE WP29	Regulation Number: ECE-51.02 Suppl. 5 Regulation Name: EXTERIOR NOISE - ECE Regulation
Diesel Emissions	System type approval of vehicles equipped with diesel engines with regard to the emission of pollutants by the engine. Static steady state test used for type approval, with free acceleration test to give a reference value for in-service testing. Choice of engine component approval, plus vehicle installation approval, or in-vehicle approval. Limits (absorption coefficients) dependent on engine	UN-ECE Regulation 24	Regulation Number: ECE-24 amended to ECE-24.03 Supp. 2. Regulation Name: DIESEL SMOKE EMISSIONS

	Regulation	Reference	Comment
	size. See Regulation for details. Free acceleration test result increased by 0.5-1 and marked close to vehicle VIN plate.		
[Type Approval + In-Service Com-plience]	Detailed regulations for type-approval and in-service compliance by all vehi-cles in India. DEFINITIONS (CMVR 2): Vehicle category definitions are as for EU and UN-ECE 1958 Agreement. Smart Cards used in driving licences, etc., must be to ISO 7816 and CMVR Annex XI.	CMVR 1989 amended to GSR 589(E) 07Oct05	Regulation Name: CENTRAL MO-TOR VEHICLE RULES Regulation Number: A03198
[Type Approval + In-Service Com-plience]	The MoRTH (Ministry of Road Transport and Highways) has issued a list of amendments to the Central Motor Vehicle Rules (CMVR) based on the SIAM Road Map and GSR 172(E). Most changes introduce re-quirements for construction equip-ment and trailers.	MoRTH	Regulation Name: Amendments to the CMVR Regulation Number: S.O 589(E)

3.1.6.2. EXHAUST GAS EMISSION

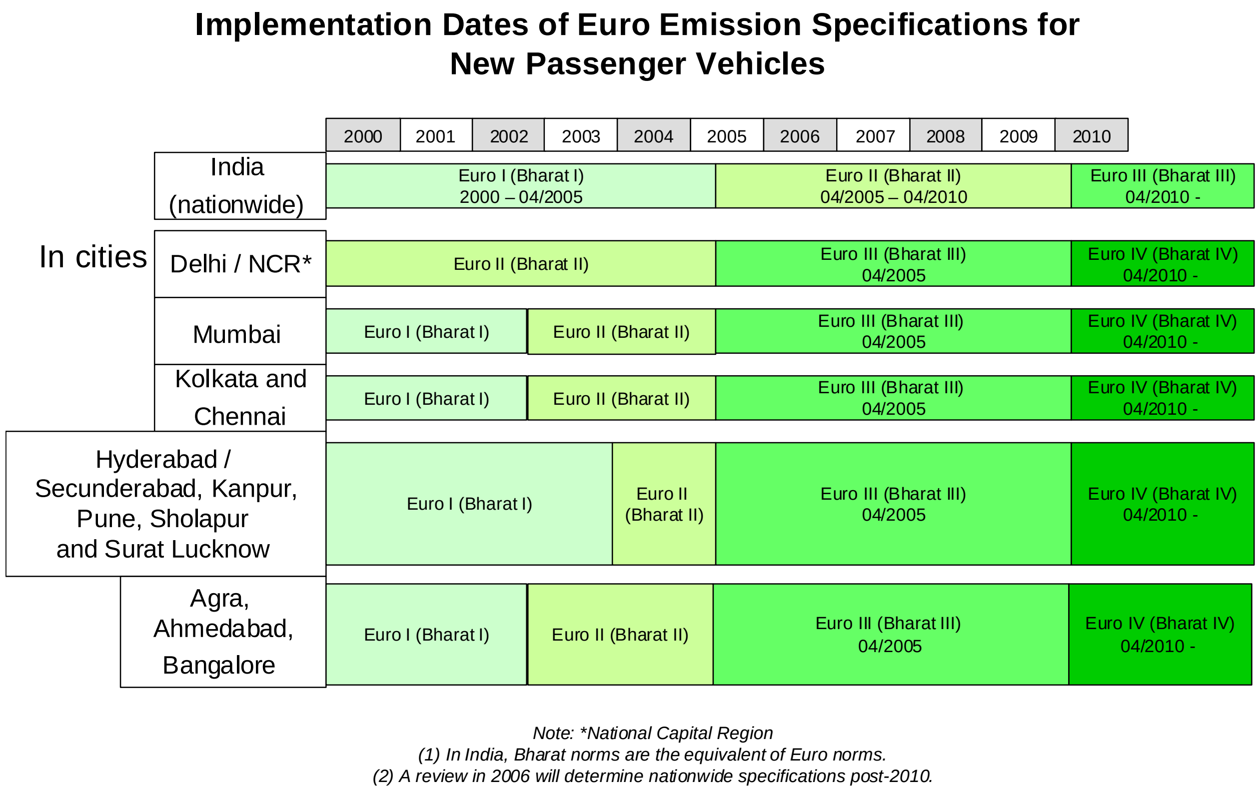


Fig. 3.1.6.2-1: Implementation Dates of Euro Emission Specifications for New Passenger Vehicles.

Driving Cycles:

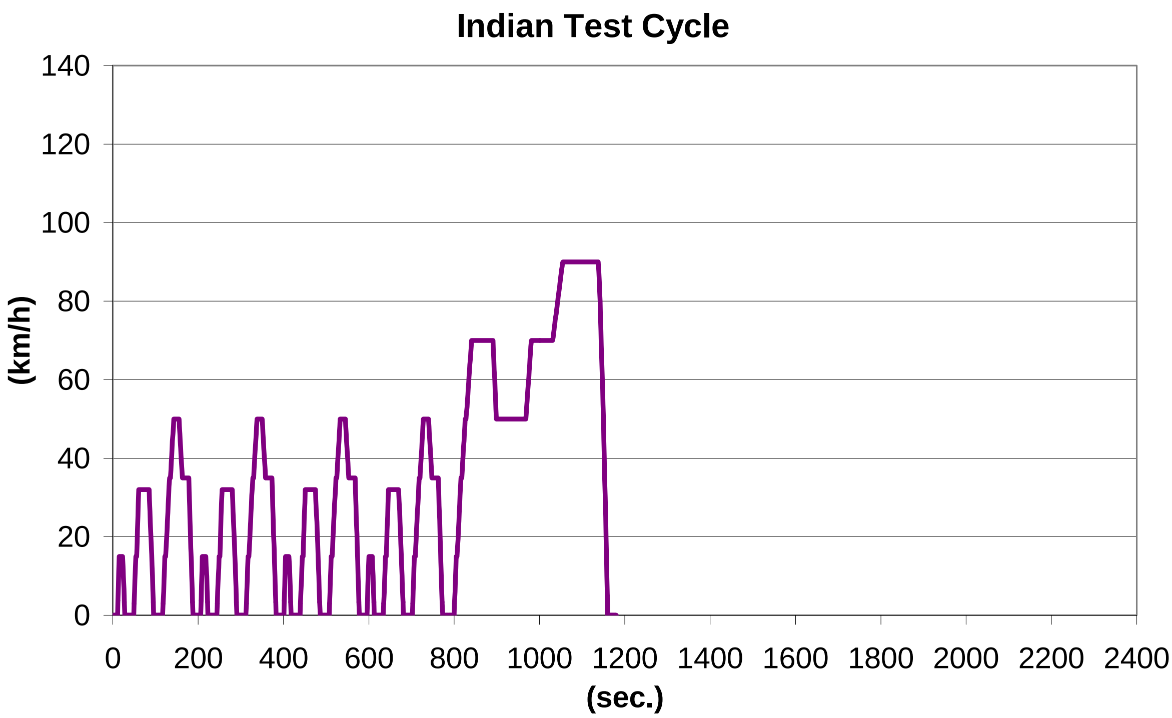


Fig. 3.1.6.2-2: Indian Test Cycle.

Tab. 3.1.6.2-1: Driving cycle summary.

Time (excl. soak)	1180 s
Distance	m
Max. Speed	90 km/h
Ave. Speed	km/h
Soak	N/A
Gear shift (man)	Fixed speeds

3.1.6.3. CO_2

Automotive Industry (SIAM) is going to issue fuel efficiency labels at the point of sale as well as fuel economy brochures. The Indian Standing committee of Sub committee on Emission under MoSRTH has proposed CO_2 limits. The limits are based on the kerb weight.

3.1.6.4. NOISE

Indian noise regulation is basically similar to ECE R-51.02 with the exception that the tyres need to have 90% of the residual tread pattern depth detailed in the ECE R-51.02.

3.1.7. RUSSIA

3.1.7.1. EXHAUST GAS EMISSION

Since April 2006, all vehicles registered in the territory of the Russian Federation must comply with the Euro II emission standards. In terms of the next stage of requirements, a time Tab. has also been adopted with Euro III emission requirements to be introduced on January 1, 2008, followed by Euro IV emission requirements by January 1, 2010, and Euro V emission requirements by January 1, 2014:

- ECE R83/04 (Euro 2) since 1.1.2002
- ECE R83/05 (Euro 3) from 1.1.2008 - draft
- ECE R83/05 (Euro 4) from 1.1.2010 - draft
- Euro 5 from 2014 – draft

3.1.7.2. NOISE

Vehicle Pass-by Noise according ECE-R51-02

3.1.7.3. INTERIOR NOISE

According the national standard GOST 51616-2000

3.1.7.4. TIRE NOISE

According ECE-R117-00 with the enforcement date 1.1.2010.

3.1.7.5. CONCENTRATION OF HARMFUL SUBSTANCES IN THE PASSENGER COMPARTMENT

According the national standard GOST 51206-98

3.1.8. BRAZIL

3.1.8.1. EXHAUST GAS EMISSION

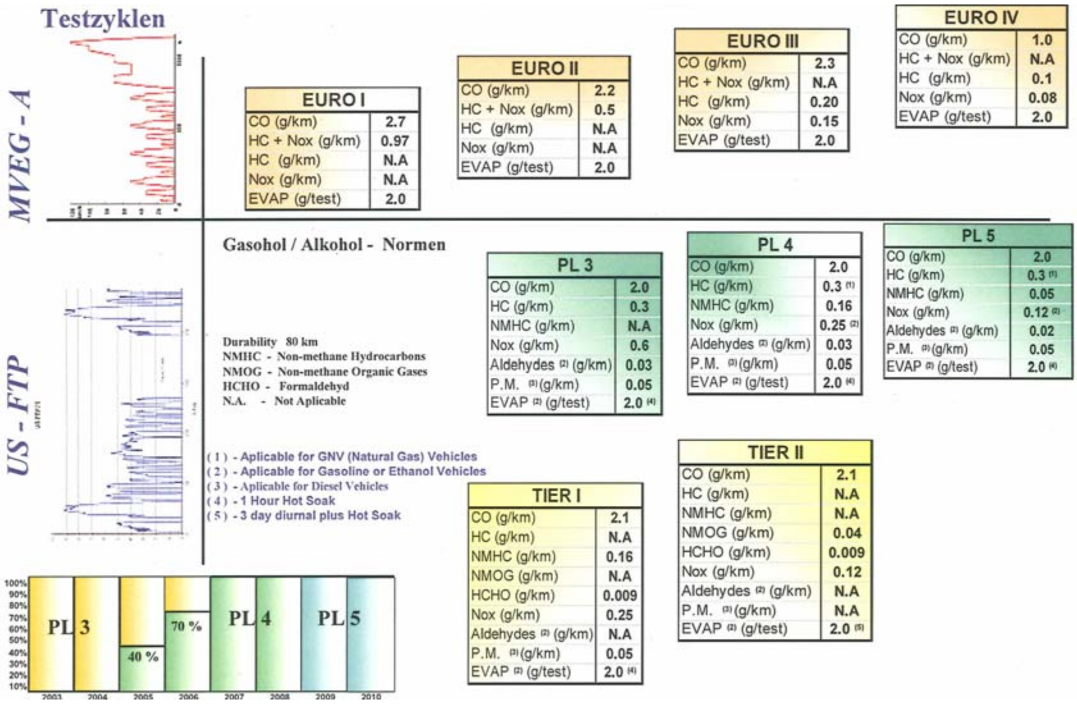


Fig. 3.1.8.1-1: Exhaust gas emission legislation.

- CONAMA Resolution No. 315/2002 PROCONVE L -5

Article 4 As of January 1st, 2009, the following maximum exhaust emission limits for light duty passenger vehicles (PROCONVE L -5) shall apply:

a) carbon monoxide (CO): 2.0 g/km;
b) total hydrocarbons (THC), only for natural gas vehicles: 0.30 g/km;
c) non-methane hydrocarbons (NMHC): 0.05 g/km;
d) nitrogen oxides (NO_x) for gasoline engines: 0.12 g/km;
e) nitrogen oxides (NO_x) for Diesel engines: 0.25 g/km;
f) aldehydes (CHO*), only for gasoline engines (except natural gas): 0.02 g/km;
g) particulate matter (PM), only for Diesel engines: 0.05 g /km;
h) content of carbon monoxide at idling speed, only for gasoline engines: 0.50% vol.

Driving Cycle: FTP75.

3.1.8.2. NOISE

Targets CONAMA Resolution No. 272/2000 in line with 70/157/EWG

Tab. 3.1.8.2-1: Maximum noise emission limits for motor vehicles.

	CATEGORY		NOISE LEVEL – dB(A)		
	DESCRIPTION		OTTO	DIESEL Injection	
				Direct	Indirect
a	Passenger vehicle up to nine seats		74	75	74
b	Passenger vehicle with more than nine seats	PBT up to 2,000 kg	76	77	76
	Cargo or traction vehicle and multi-purpose vehicle	PBT between 2,000 kg and 3,500 kg	77	78	77
c	Passenger vehicle or multi-purpose vehicle with PBT exceeding 3,500 kg	Maximum power lower than 150 kW (204 HP)	78	78	78
		Maximum power equal to or exceeding 150 kW (204 HP)	80	80	80
d	Cargo or traction vehicle with PBT exceeding 3,500 kg	Maximum power lower than 75 kW (102 HP)	77	77	77
		Maximum power be-tween 75 kW (102 HP) and 150 kW (204 HP)	78	78	78
		Maximum power equal to or exceeding 150 kW (204 HP)	80	80	80

3.1.9. AUSTRALIA

3.1.9.1. EXHAUST GAS EMISSION

ADR 79/02 Emission Control for Light Vehicles (M und N) ≤ 3,5 t gross vehicle weight.

Alternative Standards:
ECE R- 83, Revision 3, incorporating the 05 series of amendments and all amendments up to and including Supplement 1 to the 05 series of amendments

Tab. 3.1.9.1-1: ADR 79/02 Emission Control for Light Vehicles (M und N) ≤ 3,5 t gross vehicle weight.

	Date	**Date**	**Emission standard**
	New vehicles	**All vehicles**	
Gasoline	01.01.2003	01.01.2004	Euro 2
Gasoline	01.01.2005	01.01.2006	Euro 3
Gasoline	01.07.2008	01.07.2010	Euro 4
Diesel	01.01.2006	01.01.2007	Euro 2
Diesel	01.01.2006	01.01.2007	Euro 4

3.1.9.2. NOISE

ADR 83/00 – External Noise

Alternative Standards:
For M and N category vehicles, the technical requirements of United Nations Economic Commission for Europe Regulation No. 51 Uniform Provisions Concerning the Approval of Motor Vehicles Having at Least Four Wheels with Regard to Their Noise Emissions, incorporating the 02 series of Amendments, up to and including corrigendum 1 to supplement 3 to the 02 series, are deemed to be equivalent to the technical requirements of this vehicle standard

3.1.9.3 FUEL CONSUMPTION

ADR 81/02 –Fuel Consumption Labelling for Light Vehicles

Alternative Standards:
The fuel consumption values and carbon dioxide emissions values declared for the vehicle by the manufacturer in accordance with the requirements ECE R-101, Revision 2 – Amendment 1, including all amendments up to and including Supplement 7, are deemed to be equivalent to the fuel consumption values and carbon dioxide emissions values specified for that vehicle in clause 4.3 of this vehicle standard.

3.1.10. STANDARDS

- ISO 14021
- ISO 14040/44
- [ISO 14020, 14062]
- ISO 22628

< further input expected >

3.2. TOOLS FOR A HOLISTIC APPROACH

With regard to the analysis of the available literature it has to be stated that a large number of references, links and information concerning EFV can be located. Often the titles of the articles or of the websites include ambitious keywords like: 'efficiency of cars', 'global warming', 'alternative fuels', 'sustainability', 'energy consumption and the correlating emission of greenhouse gases', 'well to wheel analysis', 'lifecycle assessment' and so on. But the very most of them do not cover detailed information about the various requirements which EFV have to meet in general nor do the articles comprise concepts how to assess the environmental friendliness of cars in particular.

Since no comprehensive concept that comprises all influencing factors is available to evaluate if a vehicle is an EFV so far, the relevant issues regarding the environmental friendliness of cars have to be screened and analysed separately in order to provide the best basis for the feasibility analysis regarding the development of a holistic concept to determine and classify EFVs.

Before going into detail about the findings concerning EFV a clear distinction between the thematic priorities of the sources / literature is necessary. There are several main categories of influencing factors which affect EFVs. These categories concern particularly the energy consumption and exhaust gases emissions of EFV with regard to:

- the environmental impact of production, use and recycling of the vehicle: lifecycle considerations (LCA)
- the efficiency of fuels for road transportation: well-to-wheel (WTW) considerations

The analysis is often broken down into stages such as:
- pre-chain of the energy provisioning and supply: well-to-tank (WTT) considerations
- operation of the vehicle: tank-to-wheel (TTW) considerations

3.2.1. WELL TO WHEEL APPROACHES

3.2.1.1. EU STUDY "WELL-TO-WHEEL ANALYSIS FOR FUTURE AUTOMOTIVE FUELS AND POWERTRAINS IN THE EUROPEAN CONTEXT" BY EUCAR/CONCAVE/JRC [2]

EUCAR, CONCAWE and JRC (the Joint Research Centre of the EU Commission) regularly publish a joint evaluation of the Well-to-Wheels energy use and greenhouse gas (GHG) emissions for a wide range of potential future fuel and powertrain options relevant to Europe in 2010 and beyond [2].

Aside from the above mentioned main study additionally two separate special reports were published one concerning the well-to-tank concerns and one the tank-to-wheel aspects. Hence the two topics WTT and TTW of the EUCAR/CONCAVE/JRC study will be covered separately in the following.

- <u>WTT-Report</u>

The report identifies the potential benefits of substituting conventional fuels by alternatives.

For a well-to-tank analysis more than 100 pathways are examined regarding production, transport, manufacturing, distribution and availability of fuels on a costing basis. Two scenarios are calculated: One in which the alternative fuel was introduced or expanded in 2010-2020 and one ″business as usual″ reference scenario.

As an energy carrier, a fuel must originate from a form of primary energy, which can be either contained in a fossil feedstock or fissile material, or directly extracted from solar energy (biomass or wind power). Generally a given fuel can be produced from a number of different primary energy sources. In the study all fuels and primary energy sources have been included that appear relevant for the foreseeable future. The following matrix summarises the main combinations that have been included.

Tab. 3.2.1.1-1: Primary energy resources and automotive fuels.

Resource \ Fuel		Gasoline, Diesel, Naphtha (2010 quality)	CNG	LPG	Hydrogen (comp., liquid)	Synthetic diesel (Fischer-Tropsch)	DME	Ethanol	MTBE/ETBE	FAME/FAEE	Methanol	Electricity
Crude oil		X										
Coal					X(1)	X(1)	X				X	X
Natural gas	Piped		X		X(1)	X	X				X	X
	Remote		X(1)		X	X(1)	X(1)		X		X	X
LPG	Remote(3)			X					X			
Biomass	Sugar beet							X	[illegible]			
	Wheat							X	X			
	Wheat straw							X				
	Sugar cane							X				
	Rapeseed									X		
	Sunflower									X		
	Woody waste				X	X	X	X			X	
	Farmed wood				X	X	X	X			X	X
	Organic waste		X(2)									X
	Black liquor				X	X	X				X	X
Wind												X
Nuclear												X
Electricity					X							

(1) with/without CO_2 capture and sequestration
(2) Biogas
(3) Associated with natural gas production

- <u>TTW-Report</u>

In this study the fuel consumption respectively the greenhouse gas emissions (CO_2, CH_4, N_2O) of conventional and alternative fuels as well as powertrain options were compared. But the study was not carried out with real vehicles. This was rather done on a virtual basis. For this purpose a fictitious vehicle (similar to a VW Golf model) was considered to be the vehicle of comparison. The required data were calculated by means of computer simulation on the basis of the NEDC. Taking customer preferences into account this vehicle also had to meet some minimum requirements concerning e.g. maximum speed or acceleration.

The study is mainly addressed to future development of fuel and powertrain options (as from 2010). More detailed information about the basic results of the study are summarised in the main report.

To establish comparability a common vehicle platform representing the most widespread European segment of passenger vehicles (compact 5-seater European sedan) was used in combination with a number of powertrain options (see Tab. 3.2.1.1-2).
Key to the methodology was the requirement for all configurations to comply with a set of minimum performance criteria relevant to European customers while retaining similar characteristics of comfort, driveability and interior space. Also the appropriate technologies (engine, powertrain and after-treatment) required to comply with regulated pollutant emission regulations in force at the relevant date were assumed to be installed. Finally fuel consumptions and GHG emissions were evaluated on the basis of the current European type-approval cycle (NEDC).

Tab. 3.2.1.1-2: Automotive fuel and powertrain options covered by EUCAR/CONCAWE/JRC study.

Powertrains	PISI	DISI	DICI	Hybrid PISI	Hybrid DISI	Hybrid DICI	FC	Hybrid FC	Ref. + hyb. FC
Fuels									
Gasoline	2002 2010+	2002 2010+		2010+	2010+				2010+
Diesel fuel			2002 2010+			2010+			2010+
LPG	2002 2010+								
CNG Bi-Fuel	2002 2010+								
CNG (dedicated)	2002 2010+			2010+					
Diesel/Bio-diesel blend 95/5			2002 2010+			2010+			
Gasoline/Ethanol blend 95/5	2002 2010+	2002 2010+			2010+				
Bio-diesel			2002 2010+			2002 2010+			
DME			2002 2010+			2010+			
Synthetic diesel fuel			2002 2010+			2010+			
Methanol									2010+
Naphtha									2010+
Compressed hydrogen	2010+			2010+			2010+	2010+	
Liquid hydrogen	2010+			2010+			2010+	2010+	

PISI: Port Injection Spark Ignition
DISI: Direct Injection Spark Ignition
DICI: Direct Injection Compression Ignition
FC: Fuel cell

The study is mainly addressed to future development of fuel and powertrain options (as from 2010). More detailed information about the basic results of the study are summarised in the main report.

- Results of EUCAR/CONCAWE/JCR Study

General observations and general remarks

- Both fuel production pathway and powertrain efficiency are key to GHG emissions and energy use.
- A shift to renewable/low fossil carbon routes may offer a significant GHG reduction potential but generally requires more energy. The specific pathway is critical.
- Results must further be evaluated in the context of volume potential, feasibility, practicability, costs and customer acceptance of the pathways investigated.
- A shift to renewable/low carbon sources is currently expensive.
- GHG emission reductions always entail costs but high cost does not always result in large GHG reductions
- No single fuel pathway offers a short term route to high volumes of “low carbon” fuel
- A wider variety of fuels may be expected in the market
- Advanced biofuels and hydrogen have a higher potential for substituting fossil fuels than conventional biofuels.
- Optimum use of renewable energy sources such as biomass and wind requires consideration of the overall energy demand including stationary applications.

- The model vehicle is merely a comparison tool and is not deemed to represent the European average, a/o in terms of fuel consumption.
- The results relate to compact passenger car applications, and should not be generalized to other segments such as Heavy Duty or SUVs.
- No assumptions or forecasts were made regarding the potential of each fuel/powertrain combination to penetrate the markets in the future. In the same way, no consideration was given to availability, market share and customer acceptance.
- The study is not a Life Cycle Analysis. It does not consider the energy or the emissions involved in building the facilities and the vehicles, or the end of life phase. Other environmental aspects such as HC/NO_x/CO (Summer smog / Acidification), lands use, etc. are also not addressed.

3.2.1.2. EU-PROJECT: CLEANER DRIVE

The ″Cleaner Drive″-project [12] was part of a 5th FP European project. One Goal of ″Cleaner Drive″ was to develop a robust methodology for a vehicle environmental rating for the Community. Based on a well to wheels approach the ranking considers:

- Greenhouse gases (CO_2, CH_4, N_2O, O_3)
- Air Pollution (CO, NO_x, NMHC, SO_2, PM10)

Sources for the used data comprise type approval data and data from the EU-Project “MEET”.

Belgian Ecoscore

In 2004 the “Cleaner Drive” rating concept was compared with another similar rating method called “Ecoscore” [13, 14]. As “Cleaner Drive” the “Ecoscore” rating is based on a scale of 0 – 100 but it was developed for the capital region of Brussels and there is a slight difference in the exhaust gas components which are ranked (e.g. the greenhouse gas component O_3 is not monitored and instead of NMHC the total HC is calculated). Moreover in the Ecoscore rating the issue noise is taken into account. The emissions are weighted with different weighting factors. Ecoscore also uses type approval data and state-of-the-art data, based on the EU-Project “MEET”.

As a result of this comparison it could be seen, that both ratings are robust and indicate similar results. In the meantime an update of the Ecoscore rating was performed. The weighting factors are now suited for a mix of urban and extra urban environment, where the first version of Eco-score was targeted more towards an exclusively urban environment (eg. the damage to buildings was excluded in the update). Some pollutants were removed (eg. aromatic compounds), and the update uses external costs (ExternE) to express the impact on air quality.

An overview of the current Ecoscore methodology is shown below.

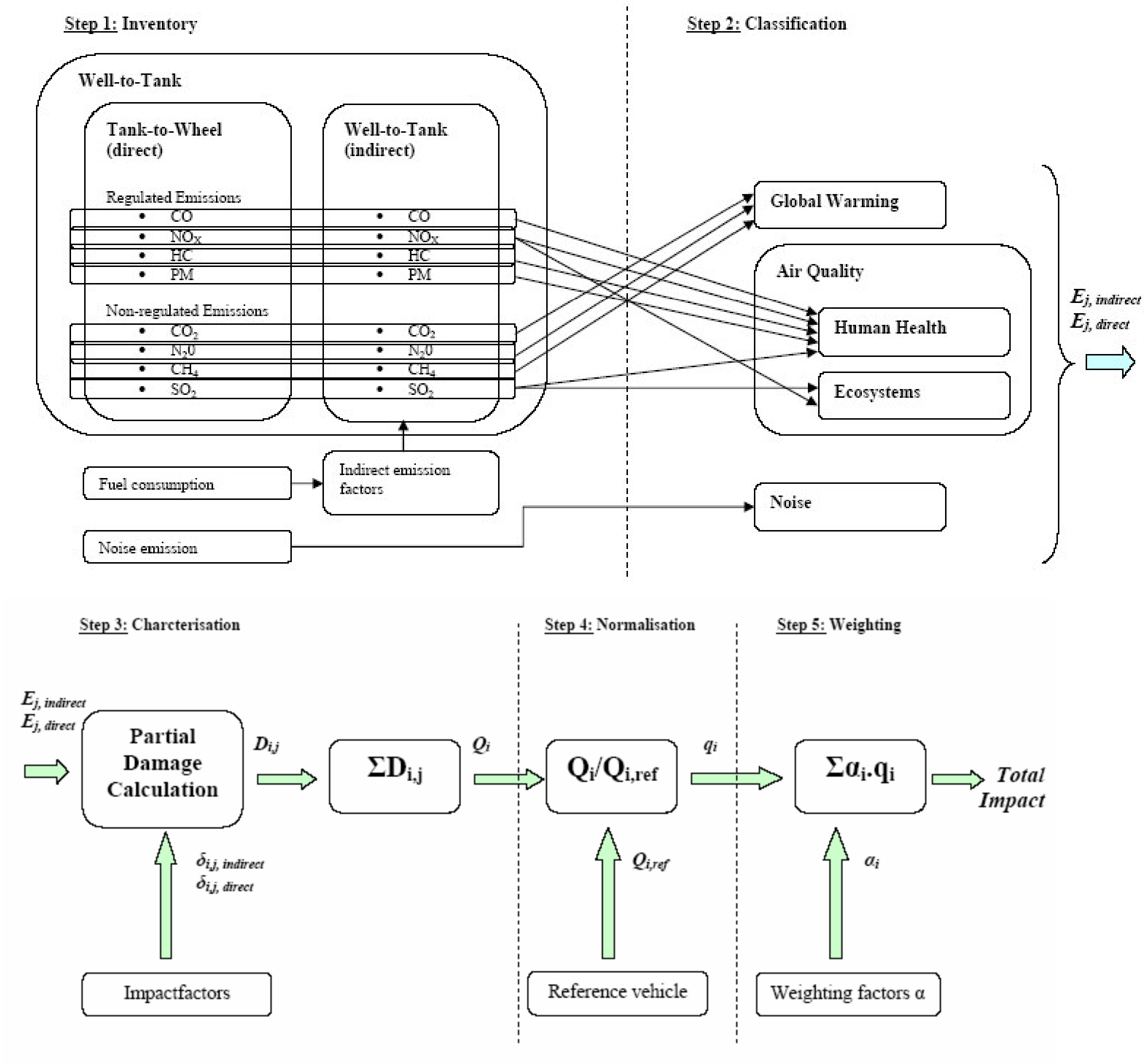


Fig. 3.2.1.2-1: Environmental rating of vehicles with different fuels and drive trains [13].

For communication purposes towards a broad public, it is important to use a score that is easy to understand. That's why the total impact (TI) is transformed into a score ranging from 0 to 100, 0 representing an infinitely polluting vehicle and 100 indicating an emission free and silent (40dB(A)) vehicle. The reference vehicle corresponds to an Ecoscore of 70. The transformation is based on an exponential function (see figure 3.2.1.2-1), so it can not deliver negative scores.

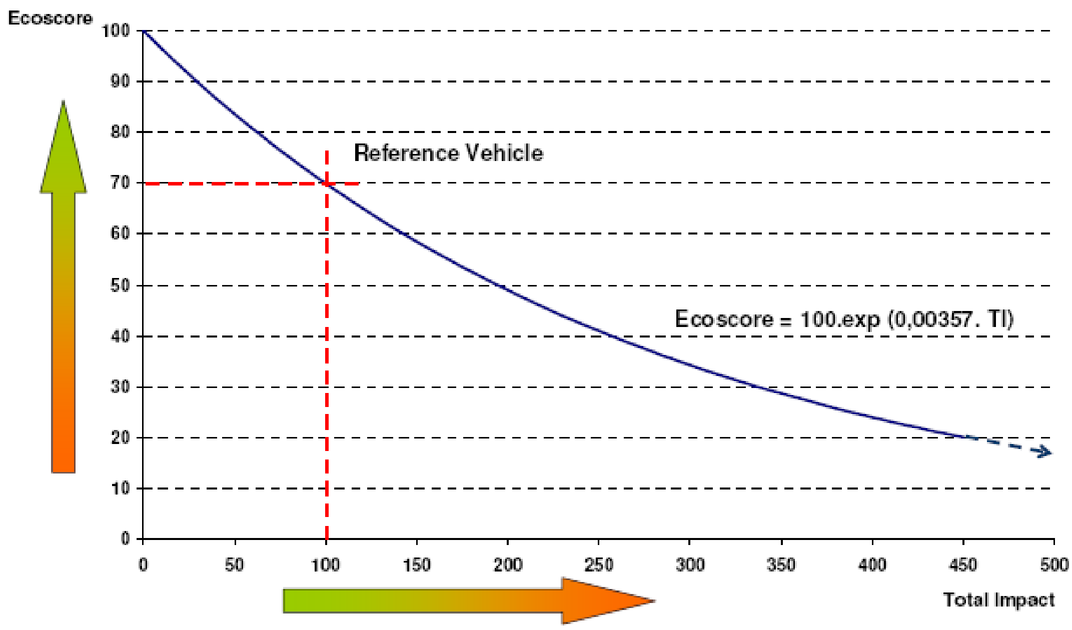


Fig. 3.2.1.2-2: …..

Ecoscore is used in the three Belgian regions (Walloon Region, Flemish region and Brussels Capital region). For information purposes a bilingual website (Dutch/French) is developed: www.ecoscore.be. This website gives rankings, the ecoscore of all passenger cars and allows you to calculate the ecoscore of your car based on the emissions from the coc (certificate of conformity) of your car. Ecoscore is also used in the Flemish Region for purchasing reasons, as well as cars purchased by the Flemish region as cars purchased by municipalities. Also the federal government and the Brussels region plan to used ecoscore as purchasing tool. The Flemish region is also planning to reform registration tax and annual vehicle tax based on the ecoscore of the car.

3.2.1.3. CONCEPT FOR AN ENVIRONMENTALLY FRIENDLY VEHICLE (EFV) FROM TNO [BASED ON EFV-02-05] [14]

Starting from the point that the whole chain (WTW analysis) has to be considered when vehicles are assessed concerning their environmentally friendliness this approach is focused on two key aspects: energy efficiency and CO_2-emissions which both have to be included into the assessment of EFVs. The TNO concept proposes a separation into a part related to the fuel side and a part related to the vehicle side. For the fuel side, the fuel production or fuel type are considered by means of CO_2 emissions or carbon content from well to wheel, per unit of energy at the tank. For the vehicle side, the main attribute is the energy efficiency of the vehicle.

In order to evaluate EFVs, the two key aspects energy efficiency (EE) and CO_2 emissions need to be combined. However, it would help to clear responsibilities (and therefore facilitate implementation) if it would be possible to separate fuel characteristics form vehicle characteristics. This concept is visualised in the following graph:

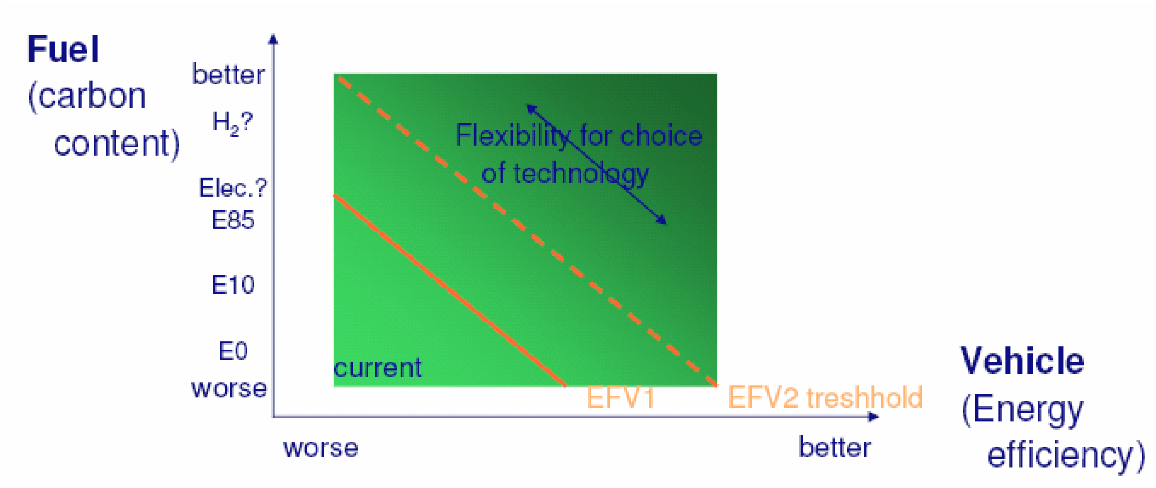


Fig.: 3.2.1.3-1: ……..

For the concept of the EFV, the following choices are proposed:

- focus on passenger cars first
- pollutant emissions need a minimum standard (eg euro 6, but could depend on region)
- Focus on well-to-wheel CO_2 emissions and energy efficiency
- A EFV criteria should be technology neutral

How to evaluate vehicles as EFV, needs to be considered in more detail; possible ways include:

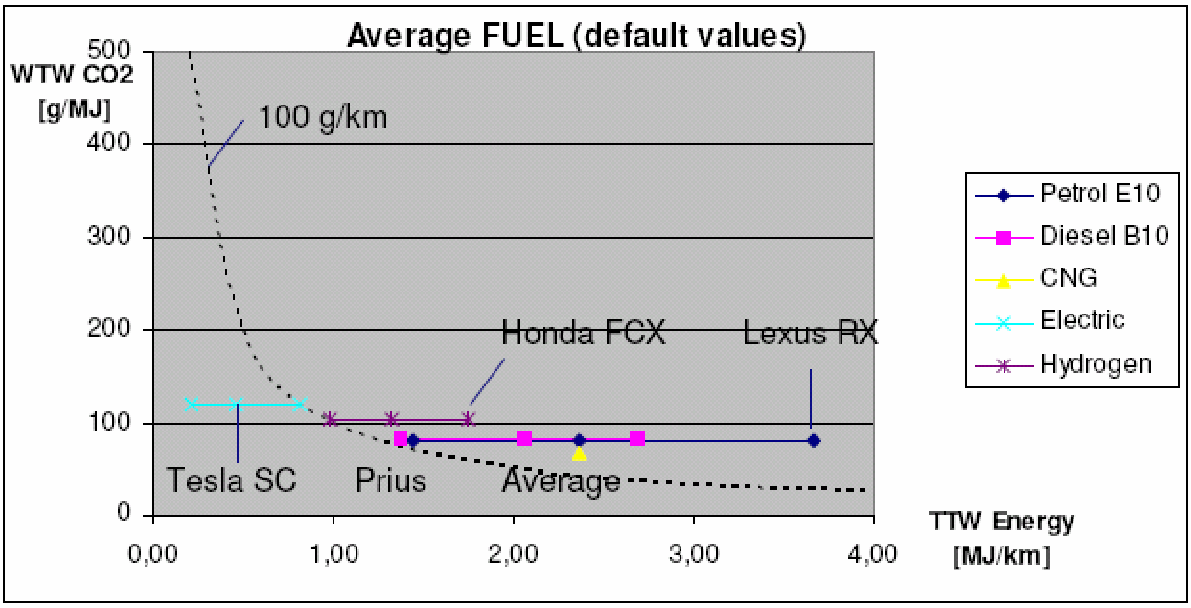


Fig.: 3.2.1.3-2: WTW CO_2 emissions versus TTW energy efficiency, but it has the disadvantage that WTT energy efficiency is not included.

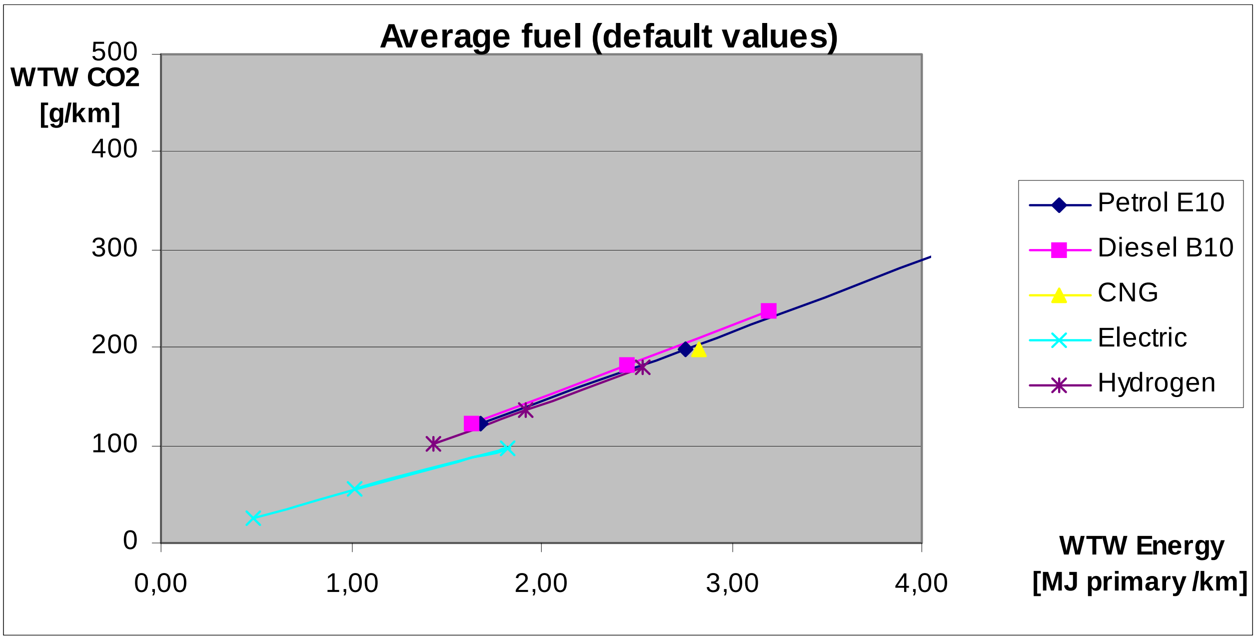


Fig.: 3.2.1.3-3: WTW CO_2 emissions versus WTW energy efficiency, but the disadvantage is horizontal axis is not independent (of the fuel characteristics).

Conclusion:
The type of criteria (for EFV) determines the most suitable graph. Therefore it is needed to further investigate the most suitable criteria for the EFV concept. It would be useful to compare more example vehicles to understand better the trade-offs.

3.2.2. LIFE CYCLE ASSESSMENT (LCA)

3.2.2.1. GREET Model (DOE USA) [17]

The U.S. *Argonne* research centre has developed the ″Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model (GREET)″ sponsored by the U.S. Department of Energy (DOE). GREET considers the full life-cycle of vehicles combining two platforms:

- The fuel-cycle module (well to wheels analysis regarding resource extraction, fuel production, transport, storage, distribution and marketing and vehicle operation)
- The vehicle-cycle module (regarding the energy and emission effects associated with vehicle material recovery and production, vehicle component fabrication, vehicle assembly and vehicle disposal/recycling)

For a given vehicle and fuel system, GREET can calculate:

- Consumption of total energy (energy in non-renewable and renewable sources), fossil fuels (petroleum, natural gas and coal together), petroleum, coal and natural gas.
- Emissions of CO_2-equivalent greenhouse gases - primarily carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).
- Emissions of six criteria pollutants: volatile organic compounds (VOCs), carbon monoxide (CO), nitrogen oxide (NO_X), particulate matter with size smaller than 10 micron (PM10), particulate matter with size smaller than 2.5 micron (PM2.5) and sulphur oxides (SO_X).

GREET can simulate more than 100 fuel production pathways and more than 70 vehicle / fuel systems. The GREET software is available at no charge.

For purposes of complying with the California Low Carbon Fuel Standard regulation, a regulated party must choose one of the methods (Method 1 or Method 2) for determining its fuel's carbon intensity value. Method 1 uses the California-modified GREET model (version 1.8b).

3.2.2.2. ACEEE's Green Book (US) [18]

The **A**merican **C**ouncil for an **E**nergy-**E**fficient **E**conomy (ACEEE) publishes a ″Green Book – The Environmental Guide to Cars and Trucks, an annual consumer-oriented guide providing environmental rating information for every new model in the U.S. lightduty vehicle market″. The Green Book is based on principles of lifecycle assessment and environmental economics. Three areas are examined:

- Manufacturing of vehicle
  ACEEE uses statistics, which estimate the average emission of each pollutant per unit of vehicle weight. These are multiplied by vehicle mass (curb weight) and divided by average vehicle lifetime mileage.
- Tailpipe emissions (CO, HC, NO_x, PM)
  ACEEE adds adjustment factors to the emission standards to which a vehicle is certified, considering that emissions can be higher in real-world driving.
- Fuel economy data
  Fuel economy data include all emission rates due to fuel lifecycle.

For assessing environmental harm done by each pollutant, the associated costs to society are estimated. Adding all these results leads to an Environmental Damage Index (EDX). The EDX is converted to a Green Score on a scale of 0-100 and a fivetier class ranking is performed (Superior, Above Average, Average, Below Average and Inferior).

The vehicles are listed in the categories:
- Best of the year (greenest models in each vehicle class)
- Greenest Vehicles of the year (highest Green Scores overall)
- Meanest Vehicles of the year (worst Green Scores overall)

As a result of the used methodology, most of the diesel-powered vehicles score "Inferior" because of their amount of NO_x.

In addition to this, further findings concerning such concepts are specified in the literature list, chapter 6. Notably [19] and [20] are worth mentioning.

3.2.2.3. LIRECAR PROJECT [ ]

Background

Guidelines for performing automotive LCA were established by a dedicated LCA working group of the **Eu**ropean **C**ouncil for **A**utomotive **R** & D (EUCAR) [19]. In a EUCAR research project cofinanced by the European Commission's research program for 'competitive and sustainable growth'. This specific screening LCA project looks at '**li**ght and **re**cyclable **car**s' (LIRECAR) in a generic way, i.e. not one specific vehicle design with its specific processes.
One guiding principle of this project was the involvement of all affected Life Cycle stakeholders from the very beginning. In an advisory group all life cycle stages are virtually represented by stakeholders. This has been seen to be important for the acceptance of the study results, as well as for enabling an optimal exploitation of the study conclusions throughout the life cycle; group members included:

- Material & Part Suppliers: Plastics*Europe* (former APME), Eurometaux, European Aluminium Association (EAA), European Association of Automotive Suppliers (CLEPA), International Iron and Steel Institute (IISI), International Magnesium Association (IMA),
- Automotive Manufacturers: Adam Opel AG, Centro Ricerche Fiat S.C.p.A, DaimlerChrysler AG, Ford-Werke AG, Regienov Renault, Volvo Car Corporation, Volkswagen AG,
- Environmental Non-Governmental Organisation (NGO): Friends of the Earth,
- Research: Institute for Prospective Technological Studies, Joint Research Centre, European Commission (JRC IPTS),
- End-of-Life: European Ferrous Recovery and Recycling Federation / European Shredder Group (EFR-ESG).

The description of LIRECAR is taken from [ ]

Approach

The goal of the LIRECAR Project is to identify and assess lightweight design and End-of-Life options from a pure environmental point of view on a life cycle basis. The goal of the study implies a comparative assertion of these options. Any other aspects (besides life cycle, lightweight

concepts and recycling issues) are out of the goal and scope of the study. In particular, changes in safety or comfort standards, propulsion improvements for CO_2 or user behavior and acceptance are out of the scope. The purpose is not to generate a general LCA/LCI data model but to answer specific questions including:

- What are the environmental impacts of lightweight design options?
- What is the importance of the EOL phase relative to other life cycle phases?
- What are the impacts of End-of-Life technology variation in the overall environmental profile?

In the LIRECAR Project, the system under consideration consists of three different sets of main vehicle scenarios. 1000 kg reference vehicles (material range of today's End-of-Life, midsized vehicles produced in the early 1990's) and 2 lightweight scenarios of 100 kg and 250 kg reduced weight (scenarios called 900 and 750, respectively) based on reference functions (in terms of comfort, safety, etc.) and vehicle concept. The scenarios represent, by their material breakdown, a broad variety of theoretical lightweight strategies – in fact up to 7 vehicle concepts are aggregated in the range of one vehicle scenario. The reference vehicle scenario has been set to ELVs (End-of-Life Vehicles) of today (produced in the 1990's).
The functional unit is defined as follows: a European, compact-sized, five-door gasoline vehicle for 5 passengers including a luggage compartment, and all functions of the defined reference scenario with a mileage of 150,000 km over 12 years, complying with the same emission standards.
The system boundaries include the whole life cycle from raw material extraction to the final recycling / disposal stage (Fig. 2.2-1). However, due to the goal of LIRECAR and the complexity of the car as a system, everything is outside the system boundaries that is too company and design specific or associated with no significant environmental burden (further details in Schmidt et al 2004).

Results

In the Fig.s (Fig. 3.2.2.3-1), the grey part in the bottom of each column stands for the potential environmental impacts of the production phase. Within this grey colored section the part below 0 per cent represents the credits given for products of the recycling phase. So, the absolute value of both sections in total indicates the potential environmental impacts of the production phase without giving credits for EOL products (no use of recycled materials in production). Looking at the basic scenario with the extreme End-of-Life assumption of recycling for shredder residue, the positive impact of recycling (credit minus EOL emissions) remains clearly below 10 per cent (often even below 3 per cent) for all impact categories, with few exemptions, while the share of the use phase is mainly 90 per cent or higher for the basic scenario. Only for total waste is the recycling credit the dominant factor, while the use phase share is around 50 per cent. Interestingly, most of these shares are very similar for the other EOL scenarios (no recycling or energy recovery of shredder residue).

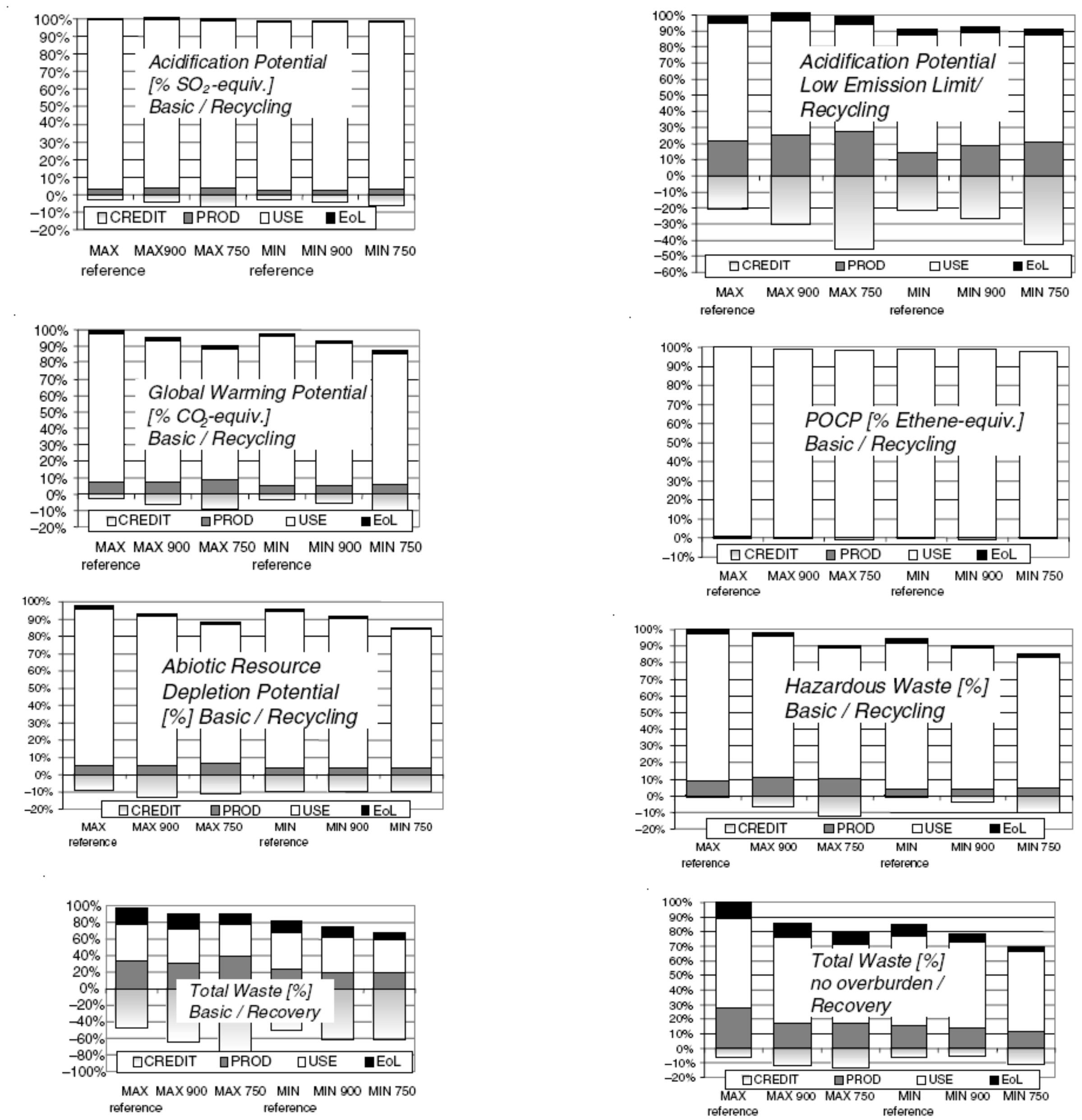


Fig. 3.2.2.3-1: Shares of different life cycle stages looking at different scenarios (8 examples for scenarios detailed in (Schmidt et al 2004)– other sensitivity results may show different results; minimum or maximum values for different LCIA parameters are not necessarily referring to the same vehicle composition per cent of max reference).

A major challenge of most LCA studies is to condense all available data without getting non-transparent for the individual scenarios and impact categories. Here, the objective is to determine whether the lightweight or End-of-Life technology variations are relevant for the different environmental categories. This should be only concluded where a significant difference between lightweight or End-of-Life scenarios can be found. Therefore, the question concerning which differences in the results of the lightweight and End-of-Life scenarios are actually significant has to be addressed considering relevant scenarios altering key assumptions (see Tab. 3.2.2.3-1 for the definition of changed key data). This is fairly difficult as there are no established statistical methods to systematically determine the significance of LCA results. As a consequence, other approaches to determine significance have to be applied. Within LIRECAR, two different crite-

ria for a significant difference are applied – the criterion 'No overlap' between the ranges of the material scenarios and the stricter criterion 'Difference larger than material range'.

Tab. 3.2.2.3-1: …….

Scenario		AP	EP	GWP	ODP	POCP	ADP	Haz. W	Total W
Basic	Lightweight	0	0	++	++	+	++	+	0
	EOL	0	0	0	0	0	0	0	+
Low emissions limit	Lightweight	0	0	++	++	+	++	+	0
	EOL	0	0	0	0	0	0	0	+
FRV 0.5	Lightweight	0	0	++	++	++	++	+	0
	EOL	0	0	0	0	0	0	0	+
FRV 0.1	Lightweight	0	0	0	++	0	0	0	0
	EOL	0	0	0	0	0	0	0	+
No EOL credit	Lightweight	0	0	0	+	+	+	0	0
	EOL	0	0	0	0	0	0	0	0
No stockpile goods	Lightweight	0	0	++	++	+	++	+	0[1]
	EOL	0	0	0	0	0	0	0	0[1]

Criterion: 'No overlap'. A '+' in terms of 'No overlap' means that the minimum value of one vehicle weight or EOL scenario is higher than the maximum value of another weight or EOL scenario
General Note: The lines 'lightweight' and 'EOL' indicate the differences between different lightweight scenarios (with the EOL treatment being the same) or different EOL treatments (with the vehicle scenario being the same)
[1] This result refers to 'Waste to be landfilled/treated' instead of 'Total waste'

Tab. 3.2.2.3-2: ……..

Scenario		AP	EP	GWP	ODP	POCP	ADP	Haz. W	Total W
Basic	Lightweight	0	0	+	++	0	+	0	0
	EOL	0	0	0	0	0	0	0	0
Low emissions limit	Lightweight	0	0	+	++	0	+	0	0
	EOL	0	0	0	0	0	0	0	0
FRV 0.5	Lightweight	0	0	++	++	+	+	0	0
	EOL	0	0	0	0	0	0	0	0
FRV 0.1	Lightweight	0	0	0	0	0	0	0	0
	EOL	0	0	0	0	0	0	0	0
No EOL credit	Lightweight	0	0	0	0	0	0	0	0
	EOL	0	0	0	0	0	0	0	0
No stockpile goods	Lightweight	0	0	+	++	0	+	0	0[1]
	EOL	0	0	0	0	0	0	0	0[1]

Criterion: 'Difference larger than material range'. A '+' means that the difference between the minimum value of one weight or EOL scenario and another weight or EOL scenario is larger than the largest range between the minimum and maximum value of one of the vehicle or EOL scenarios
General Note: The lines 'lightweight' and 'EOL' indicate the differences between different lightweight scenarios (with the EOL treatment being the same) or different EOL treatments (with the vehicle scenario being the same)
[1] This result refers to "Waste to be landfilled/treated" instead of 'Total waste'

AP – Acidification Potential
EP – Eutrophication Potential
ODP – Ozone Depletion Potential
POCP – Photochemical Oxidant Creation Potential
ADP – Abiotic Resource Depletion Potential
Haz W – Hazardous Waste

Looking at the three main questions, the following conclusions are drawn by LIRECAR:

3.2.2.4. LCA CONCEPTS FROM VEHICLE MANUFACTURERS

The methodological details in applying the life cycle concept are not fully aligned between the vehicle manufacturer reflecting different vehicle segments, approaches, target groups etc. Comparability is only given within one study. LCA's for passenger vehicles require several simplifications and data estimates. The complex information may lead to confusion and mis-leading conclusions by customers and regulators. Aggregation of LCA results to a single-score is not allowed according to ISO14040 (no scientific basis for single-score/biased weighting).

- **Mercedes** [20]

Mercedes uses Life Cycle Assessments to compare the latest models with their predecessors. These are based on ISO 14020, 14021, 14040, 14044 and 14062. The examined areas are:

- Vehicle Production
- Fuel Production
- Operation (covered distance: 150 000 km in NEDC)
- Recycling

The selected parameters are:

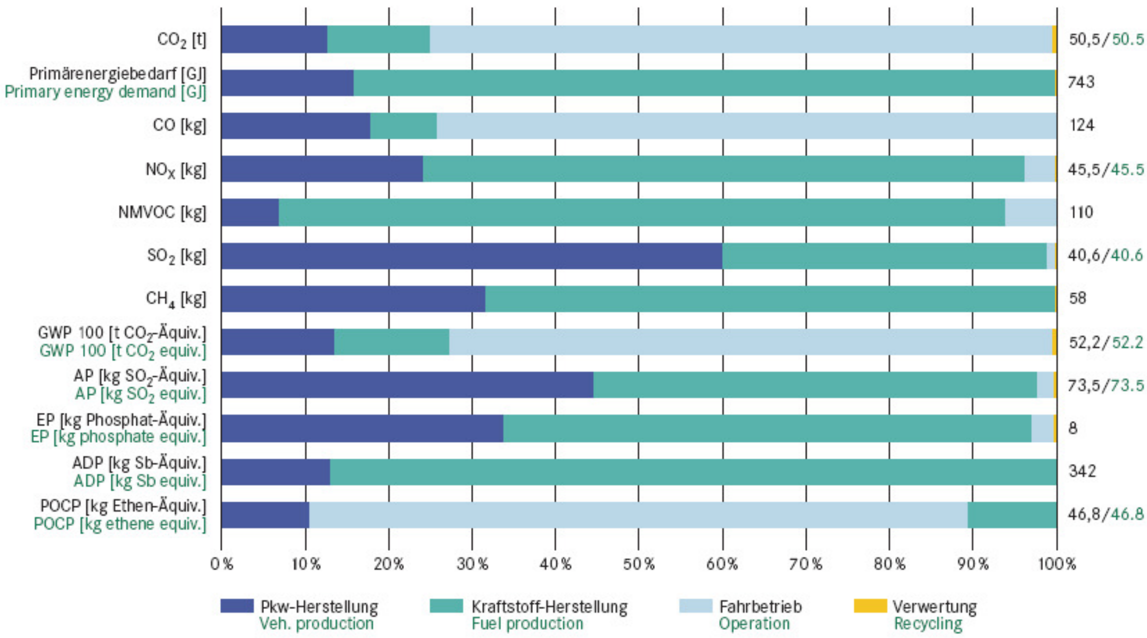


Fig. 3.2.2.4-1: Selected parameters from Mercedes LCA.

The results of the Life Cycle Assessment have been verified and certified by TÜV SÜD.

Mercedes awards its analysed cars with an Environmental Certificate (Umwelt- Zertifikat).

➢ **VW** [21]

VW also uses life cycle assessments in accordance with ISO 1440/44 to compare the latest models with their predecessors. The following areas are examined:

- Engine / transmission manufacture
- Vehicle manufacture
- Fuel supply
- Driving emissions (covered distance: 150 000 km in NEDC)
- Recycling

In a Life Cycle Inventory, data is collected for primary energy demand as well as for emissions of CO_2, CO, SO_2, NO_x, NMVCO and CH_4.

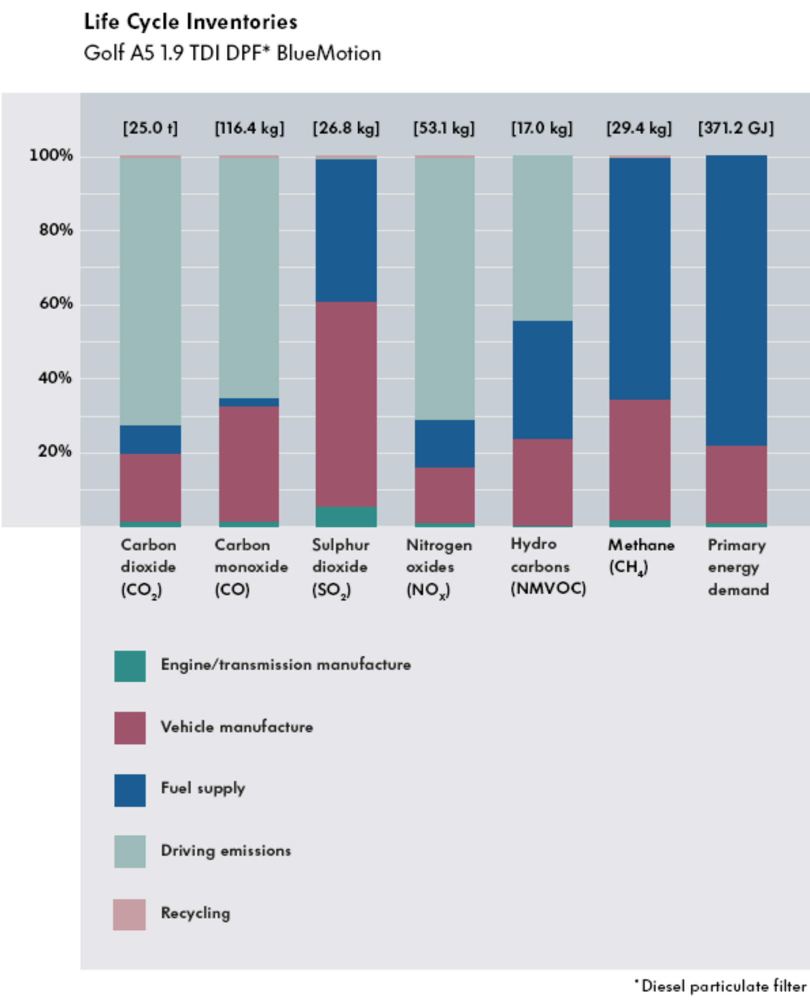


Fig. 3.2.2.4-2: Life Cycle Inventories VW.

Furthermore a Live Cycle Impact Assessment is made concerning Global Warming Potential (CO_2 equivalents), Photochemical Ozone (Ethene-equivalents), Acidification (SO_2 equivalents)**,** Ozone Depletion (R11-equivalents) and Eutrophication (PO_4- equivalents).

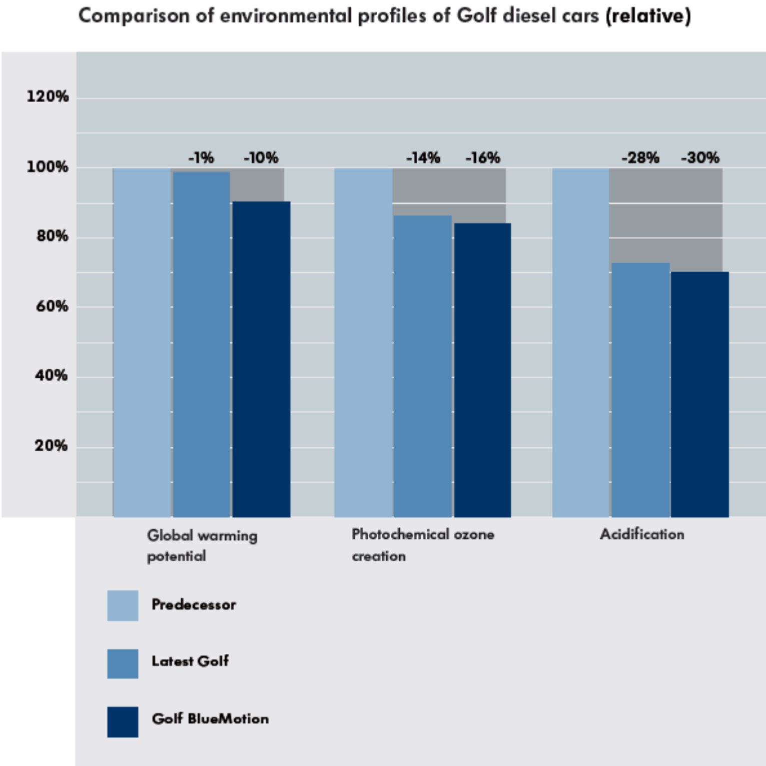


Fig. 3.2.2.4-3: Comparison of environmental profiles of golf diesel cars (relative).

The results of the Life Cycle Assessment have been verified and certified by TÜV NORD.

To provide interested parties with detailed information about the environmental performance of its vehicles and technologies, VW uses Environmental Commendations (so-called "Umwelt-prädikat").

- **Volvo Cars' Environmental Product Information** [22]

Volvo Car publishes an Environmental Product Information for its vehicles. Information about environmental management, production, useful life and recycling are provided in a life cycle diagram:

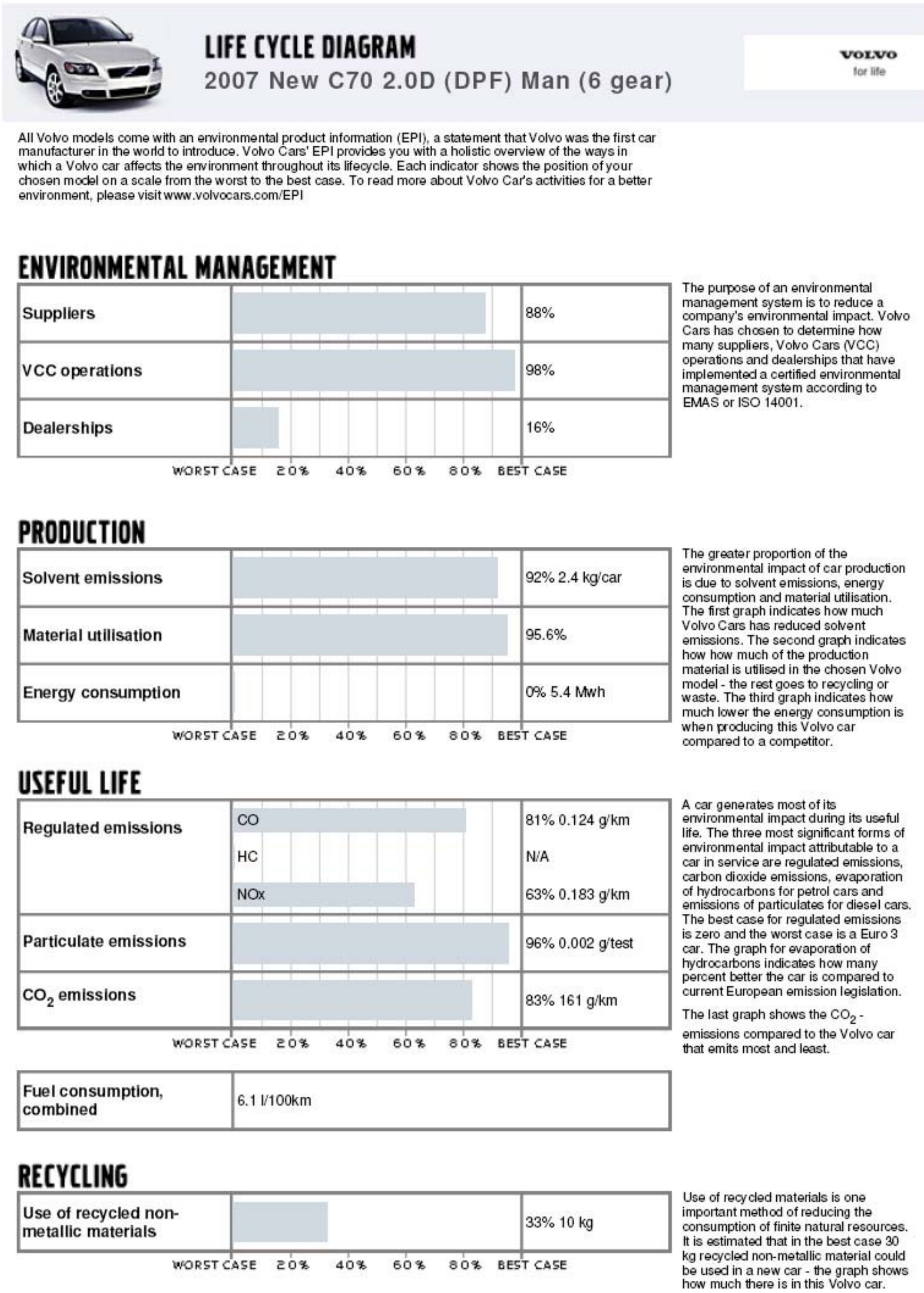


Fig. 3.2.2.4-4: Life Cycle Diagram Volvo.

➢ **Ford of Europe's Product Sustainability Index** [23]

Ford uses Life Cycle Assessment (LCA) certified against ISO 14040 series to compare a vehicle with its predecessor respectively the industry performance along the vehicle and fuel life cycle.

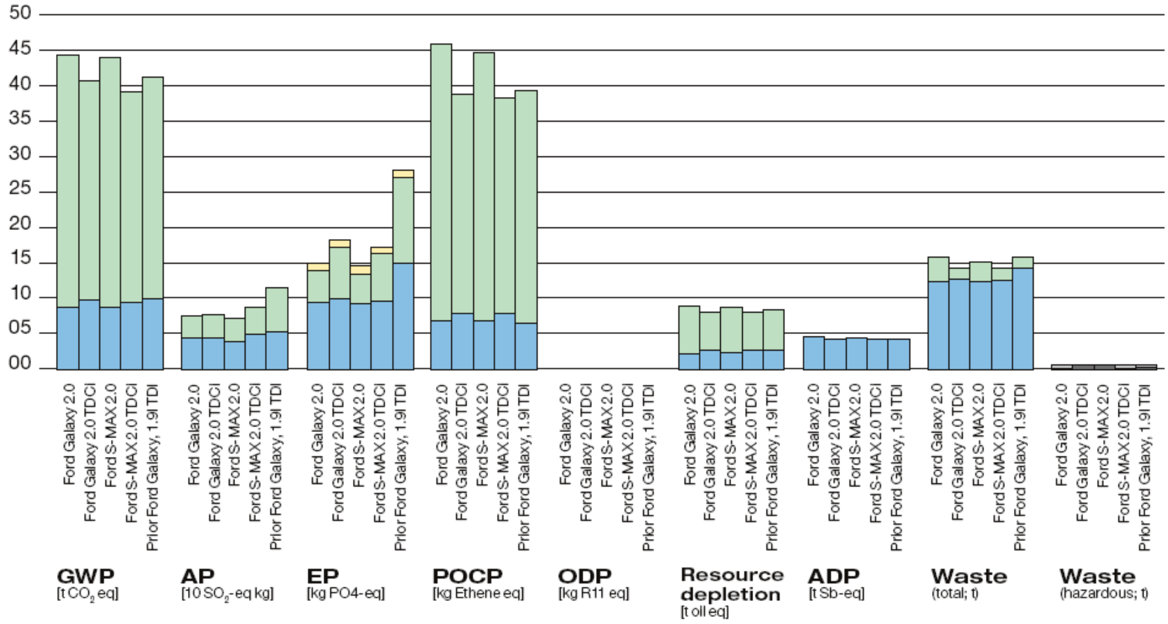


Fig. 3.2.2.4-5: Comparison of environmental profiles of Ford Galaxy (current vs predecessor), and Ford S-MAX.

In spite of its complexity LCA is not comprehensive enough. Therefore, Ford broadens the LCA assessment to a "Product Sustainability Index" by adding other environmental aspects and putting them into perspective looking also at societal and life cycle cost items (Fig 3.2.2.4-6). The methodology might be further developed and is completed by indicators for other company areas (e.g. manufacturing etc.).

	Indicator	Metric / Method	Driver for Inclusion
Environ-mental and health	Life Cycle Global Warming	Greenhouse emissions along the life cycle (CO_2 and equivalent emissions from raw material extraction through production, use to recovery) – part of an LCA according to ISO 14040	Carbon intensity is the main strategic issue in automotive industry
	Life Cycle Air Quality	Emissions related to Summer Smog along the life cycle (Ethene and equivalent emissions) – part of an LCA according to ISO 14040	Potential trade-offs between CO_2 and non-CO_2 emissions
	Sustainable Materials	Recycled and natural materials related to all polymers[1]	Resource Scarcity
	Substance Management	Vehicle Interior Air Quality (VIAQ) / allergy-tested interior, management of substances along the supply chain	Substance risk management is key
	Drive-by-Noise	Drive-by-Exterior Noise = dB(A)	Main societal concern
Societal[2]	Safety	Including EuroNCAP stars (including occupant and pedestrian protection)	Main direct impact
	Mobility Capability	Mobility capacity (seats, luggage) to vehicle size	Crowded cities (future issues include: diversity – disabled drivers, etc.)
Economics	Life Cycle Cost	Sum of vehicle price and 3 years service (fuel cost, maintenance cost, taxation) minus residual value (note: for simplification reasons cost have been tracked for one selected market; Life Cycle Costing approach using discounting)	Customer focus, competitiveness

[1] Note: There are, of course, no materials that are inherently sustainable. All materials are linked to environmental, social and economic impacts. However, recycled materials and renewably grown, natural fibers represent an example of how limited resources can be used in a more sustainable way. The overriding factor is whether or not these materials have, in their specific application, a lower environmental impact through the product life cycle than potential alternative materials (see life cycle related PSI indicators and previous paper [24]).
[2] Note: The social aspects are being refined and developed for the future. Please note that aspects related to labor, rights etc. are part of other Ford of Europe sustainability management tools such as the MSI.

Fig. 3.2.2.4-6: Indicators of the Ford Product Sustainability Index.

3.3. ASSESSMENT CONCEPTS

It has to be taken into consideration that the findings within the literature review carried out are addressed to different target groups. Some sources / articles are focussed on measures related to e.g. benefits for users of EFVs (for instance: reduced or no charges to enter cities (city-toll) and financial / tax incentives) and other articles pursue specific purposes of consumer information such as labelling concerns or eco-ratings. The latter take into account at least CO_2-emissions / fuel consumption or possibly even pollutant emissions and sometimes noise emissions as well. Although noise plays an important role it is not considered as a major concern within these findings.

3.3.1. CONCEPTS AND RANKINGS FROM PUBLIC AUTHORITIES

This chapter includes some examples. Further concepts and programs based on governmental initiatives in order to provide the users with relevant information benefits. This was not examined within a greater extent within this study until now.

3.3.1.1. ENVIRONMENTAL PERFORMANCE LABEL FROM CARB

In California all new cars beginning with the 2009 model year are required to display an ″Environmental Performance″ label (EP label) [24], providing a ″Smog Score″ and a ″Global Warming Score″ – each having unique environmental impacts.
The EP label scores a vehicle's global warming and smog emissions from 1 – 10 (in each score) with the highest scores being the cleanest vehicle options.

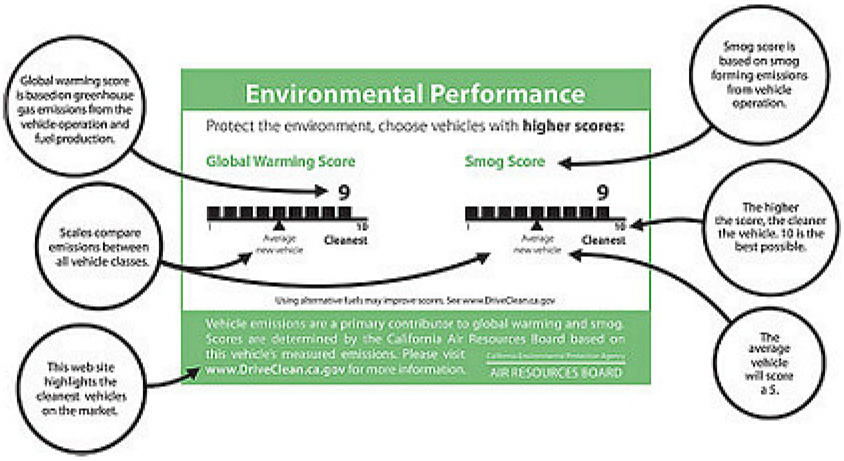


Fig. 3.3.1.1-1: Environmental Performance.

The global warming score reflects the emissions of greenhouse gases from the vehicle's operation and fuel production. It is based on the sum of vehicle's greenhouse gas emissions which are identified as the CO_2-equivalent value. The measured emissions include Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_20) and emissions related to the use of air conditioning. The global warming score ranks each vehicle's CO_2-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.

The corresponding Tab. shows the 10 CO_2-equivalent levels. The average vehicle available in California today will get a global warming score of 5.

Tab. 3.3.1.1-1: Global warming score and CO_2-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

Tab. 3.3.1.1-2: Smog Score and pollutant levels of non-methane organic gases (NMOG) and oxides of nitrogen (NO_X).

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

* A smog score of 9 was given to vehicles certifying tot he 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

The Smog Score is based on the smog forming emissions from the vehicle's operation and ranks the pollutant levels of non-methane organic gases (NMOG) and oxides of 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.

3.3.1.2. GREEN VEHICLE GUIDE FROM THE AUSTRALIAN GOVERNMENT

The Green Vehicle Guide [25] is an Australian Government Initiative and is based on tailpipe emissions. Two categories are separately weighted:

- Greenhouse Rating (weighting 50 per cent)
  The Greenhouse Rating rests upon the CO_2 emission value
- Air Pollution Rating (weighting 50 per cent)

The Air Pollution Rating rests upon the Australian emission standards but a precise distinction into two stages is applied. Stage 1 covers the air pollution ratings applicable in 2004 and 2005 and stage 2 those applicable from 1 January 2006.
Due to the large sized Tab.s concerning stage 1 and stage 2 ratings only some stage 2 data are depicted below, however the logical configuration is the same in stage 1.

Tab. 3.3.1.2-1: Greenhouse ratings and CO_2 Emissions.

Greenhouse Rating	CO_2 Emissions (combined g/km)	Greenhouse Rating	CO_2 Emissions (combined g/km)
10 (0–10)	<= 60	5 (0–10)	241 - 260
9.5 (0–10)	61 - 80	4.5 (0–10)	261 - 280
9 (0–10)	81 - 100	4 (0–10)	281 - 300
8.5 (0–10)	101 - 120	3.5 (0–10)	301 - 320
8 (0–10)	121 - 140	3 (0–10)	321 - 340
7.5 (0–10)	141 - 160	2.5 (0–10)	341 - 360
7 (0–10)	161 - 180	2 (0–10)	361 - 380
6.5 (0–10)	181 - 200	1.5 (0–10)	381 - 400
6 (0–10)	201 - 220	1 (0–10)	401 - 420
5.5 (0–10)	221 - 240	0.5 (0–10)	421 - 440

Tab. 3.3.1.2-2: Stage 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
10	Electric	All	All	-	-	-	-	-
8.5	Petrol, LPG, NG	All	ADR79/02	*Euro 4* certification and HC $\leq$ 0.035g/km and NOx $\leq$ 0.028g/km[iii]	Beyond *Euro 4*	0.035	0.028	-
	Diesel	All	ADR79/01	HC $\leq$ 0.035g/km and NOx $\leq$ 0.028g/km and PM $\leq$ 0.00875g/km[iv]	Beyond *Euro 4*	0.035	0.028	0.00875
6.5	Petrol, LPG, NG	Passenger Goods carrying (RM $\leq$ 1305)	ADR79/02	*Euro 4* certification	*Euro 4*	0.10	0.08	-
6	Petrol, LPG, NG	Goods carrying (1305 < RM $\leq$ 1760)	ADR79/02	*Euro 4* certification	*Euro 4*	0.13	0.10	-
5.5	Petrol, LPG, NG	Goods carrying (RM > 1760)	ADR79/02	*Euro 4* certification	*Euro 4*	0.16	0.11	-
5	Petrol, LPG, NG	Passenger Goods carrying (RM $\leq$ 1305)	ADR79/01	-	*Euro 3*	0.20	0.15	-
	Diesel	Passenger Goods carrying (RM $\leq$ 1305)	ADR79/01	-	*Euro 4*	HC + NOx $\leq$ 0.30	0.25	0.025
4.5	Petrol	Goods carrying (1305 < RM $\leq$ 1760)	ADR79/01	-	*Euro 3*	0.25	0.18	-
4	Petrol, LPG, NG	Goods carrying (RM > 1760)	ADR79/01	-	*Euro 3*	0.29	0.21	-
	Diesel	Goods carrying (1305 < RM $\leq$ 1760)	ADR79/01	-	*Euro 4*	HC + NOx $\leq$ 0.39	0.33	0.04
3	Diesel	Goods carrying (RM > 1760)	ADR79/01	-	*Euro 4*	HC + NOx $\leq$ 0.46	0.39	0.06
2.5	Diesel	Passenger Goods carrying (RM $\leq$ 1305)	ADR79/00	*Euro 3* certification	*Euro 3*	HC + NOx $\leq$ 0.56	0.50	0.05
2	Diesel	Goods carrying (1305 < RM $\leq$ 1760)	ADR79/00	*Euro 3* certification	*Euro 3*	HC + NOx $\leq$ 0.72	0.65	0.07
	Diesel	Passenger Goods carrying (RM $\leq$ 1250)	ADR79/00	-	*Euro 2*	HC + NOx $\leq$ 0.70		0.08
1.5	Diesel	Goods carrying (RM > 1760)	ADR79/00	*Euro 3* certification	*Euro 3*	HC + NOx $\leq$ 0.86	0.78	0.10
1	Diesel	Goods carrying (1250 < RM $\leq$ 1700)	ADR79/00	-	*Euro 2*	HC + NOx $\leq$ 1.00		0.12
0.5	Diesel	Goods vehicles (RM > 1700)	ADR79/00	-	*Euro 2*	HC + NOx $\leq$ 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.

An overall star rating is generated by combining Air Pollution Score and Greenhouse Score:

Overall Rating	Combined Air Pollution & Greenhouse Score
★★★★★	combined score >= 16
★★★★½	15 <= combined score < 16
★★★★	14 <= combined score < 15
★★★½	11.5 <= combined score < 14
★★★	9.5 <= combined score < 11.5
★★½	8 <= combined score < 9.5
★★	6.5 <= combined score < 8
★½	5 <= combined score < 6.5
★	combined score < 5

Fig. 3.3.1.2-1: Overall star rating.

3.3.1.3. GREEN VEHICLE GUIDE FROM US EPA

The Environmental Protection Agency (EPA) also publishes a "Green Vehicle Guide" [26, 27]: 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

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

Air Pollution Score
MY 2009+

Score	US EPA Tier 2 Emission Standard	California Air Resources Board LEV II Emission Standard
10	Bin 1	ZEV
9	Bin 2	SULEV II
8	Bin 3	--
7	Bin 4	ULEV II
6	Bin 5	LEV II
5	Bin 6	LEV II option 1
4	Bin 7	--
3	Bin 8	SULEV II lg trucks
2	--	ULEV II lg trucks
1	--	LEV II lg trucks
0	--	--

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

Fig. 3.3.1.3-1: Air Pollution Score.

- 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 (Fig. 3.3.1.3-2) 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 a different carbon content per gallon. This means each fuel creates different levels of CO_2 emissions per gallon. The overall GHG-scoring relates to the WTW emissions.

A score from 0 to 10 reflects the amount of CO_2, N_2O and CH_4 emissions. The score is based on the methodology of the Department of Energy's GREET model. (The GREET model is explained more detailed in chapter 3.2.2.1. Category Life Cycle Assessment)

Greenhouse Gas Score Criteria MY 2008 & Earlier						
		Minimum Label MPG (combined)				
GHG Score	Pounds CO2e per mile	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+						
		Minimum Label MPG (combined)				
GHG Score	Pounds CO2e per mile	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

Fig. 3.3.1.3-2: Greenhouse Gas Score Criteria.

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 labelled with the SmartWay designation and vehicles, which rate 9 or better on each of the both scores are labelled 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 means the vehicles scores well on both Air Pollution and Greenhouse Gas.

3.3.1.4. ″ECO-CAR″ CONCEPTS FROM SWEDEN

In some countries incentives are provided for users of environmentally friendly vehicles.
The legal basis for giving special subsidies depends on regional or national action plans. The demands that such vehicles have to comply with can comprise diverse issues deriving from particularly tank-to-wheel or well-to-tank aspects as well as from LCA terms. The following concept from Sweden [28] is an example for such a scheme building the basis for incentives.

At present (over a period from 01.04.2007 – 31.12.2009) in Sweden private persons get a subsidy of 10.000 Skr (~ 1.100 €) for registration of a new ″eco-car″ which meets certain environmental requirements. For this purpose the Swedish government provides an amount of 250 Million Skr. The definition of eco-cars is the following:

- vehicles with alternative fuels (e.g. ethanol):
  energy consumption less than
  - 9,2 l fuel[1]/100 km
  - 9,7 m3 CNG/100 km
  - 37 kWh electric energy/100 km
- vehicles with conventional fuels (including hybrids):
  CO_2- emissions less than
  - 120 g/km
  - and additionally for diesel-engined vehicles: PM < 5 mg/km

In addition there is a reduced taxation of company cars which are running on alternative fuels or which are equipped with a particle filter in case of diesel vehicles respectively. In Stockholm such cars are exempted from congestion charges. And in some cities and communities environmentally friendly vehicles can park for free or at a reduced price (or: at a cheaper rate?) if they comply with the local requirements. In Sweden as a minimum 85 per cent of the vehicles used from public authorities must be ecocars.

3.3.1.5. JAPANESE ECO-RANKING SYSTEMS

Promoting the Widespread Use of Fuel-Efficient Vehicles

Auto manufactures in Japan made all-out efforts to achieve early compliance with 2010 fuel efficiency targets in response to consumer demand. Also, the central government introduced tax incentives for the purchase of low-emission and fuel-efficient vehicles, which are designated as such by means of an environmental performance certification system.

Japan´s Green Tax Scheme:

- Reductions on the Automobile Tax (introduced in 2001)
  Reduction on the Automobile Tax are applied to low-emission and fuel-efficient vehicles. (Note: 10 % surcharges on the tax are mandated for diesel vehicles on the road 11 years or longer, and for gasoline vehicles on the road 13 years or longer, since first registration)

- Reductions on the Acquisition Tax (introduced in 1999)
  Financial incentives are applied to the Acquisition Tax for purchasers of low-emission and fuel-efficient vehicles.

[1] The fuel consumption is calculated as for operation with petrol since E85 test specifications are not available yet. The lower caloric value of E85 results in higher fuel consumption of about 30 per cent compared with the gasoline operating mode.

Tab. 3.3.1.5-1: CO_2 Reduction in Global Road Transport [Source: Reducing CO_2 Emissions in the Global Road Transport Sector (JAMA, August 2008)]

	Emissions Performance	Fuel efficiency	Incentives	
			Automobil Tax	Acquisition Tax
Passenger Cars	Emission down by 75 % from 2005 standards	Compliant + 25 % compared to 2010 standards	50 % reduction	Amount deducted: ¥ 300,000
		Compliant + 15 % compared to 2010 standards	25 % reduction	Amount deducted: ¥ 150,000
Heavy-Duty Vehicles	Compliance with 2009 Standard	Compliant with 2015 standards	–	2 % reduction
			–	

Promoting Vehicles with Greater Fuel Efficiency and Lower Emissions [29]:

Vehicles with greater fuel efficiency help counter global warming through their reduced emission of CO_2, while vehicles with reduced tailpipe emissions help improve air quality. The Japanese government has established one certification system for gasoline and diesel vehicles as well as heavy-duty trucks and buses with advanced fuel efficiency; another certification system for gasoline and diesel (including heavy-duty) vehicles whose emissions performance is superior to current regulatory levels for carbon monoxide (CO), nitrogen oxides (NO_x), and particulate matter (PM); and a third certification system for trucks and buses that comply either with 2005 emission (including NO_x and PM) standards or with the “long-term” or “new short-term” regulatory standards. To promote widespread public awareness of vehicles with advanced fuel efficiency and/or low emissions, such vehicles are identified with appropriately coded stickers.

For Gasoline and LPG Vehicles

Rating/Performance Level		Vehicle Sticker
Compliant +25% compared to standards	Performing 25% better or more compared to 2010 target fuel efficiency standards	
Compliant +20% compared to standards	Performing 20% better or more compared to 2010 target fuel efficiency standards	
Compliant +15% compared to standards	Performing 15% better or more compared to 2010 target fuel efficiency standards	

For Diesel Vehicles

Rating/Performance Level		Vehicle Sticker
Compliant +25% compared to standards	Performing 25% better or more compared to 2005 fuel efficiency standards	
Compliant +20% compared to standards	Performing 20% better or more compared to 2005 fuel efficiency standards	
Compliant +15% compared to standards	Performing 15% better or more compared to 2005 fuel efficiency standards	

For Trucks and Buses with GVW>3.5 tons

Rating/Performance Level		Vehicle Sticker
Compliant with standards	Meeting 2015 target fuel efficiency standards or better	

Fig. 3.3.1.5-1: Advanced fuel efficiency certification.

Rating/Performance Level		Vehicle Sticker
☆☆☆☆	Emissions down by 75% from 2005 standards	
☆☆☆	Emissions down by 50% from 2005 standards	
★	Heavy-duty diesel vehicles with NOx and PM emissions down by 10% from 2005 standards	
☆	Heavy-duty diesel vehicles with NOx emissions down by 10% from 2005 standards	
☆	Heavy-duty diesel vehicles with PM emissions down by 10% from 2005 standards	

Fig. 3.3.1.5-2: Environmental performance certification for vehicles with low emissions.

Rating/Performance Level	Vehicle Sticker
Compliant with 2005 emission standards	
Compliant with other regulatory standards (see above)	

Fig. 3.3.1.5-3: Low NO_x & PM emissions certification for trucks and buses.

3.3.2. ECO RANKING BY CONSUMER ASSOCIATIONS

Most of the screened articles reflect to the purpose consumer information especially those with regard to eco-ratings.

Currently there are only few references available which give some advice how an assessment of environmentally friendly cars could be arranged on tank-to-wheel basis which are the major criteria that vehicles have to fulfil in order to score well in the corresponding lists ranking the environmental friendliness. Due to the fact that the quality level of the articles diverges very much it is beyond the question that the various assessment concepts can always be described with the same accuracy.

Promising references with suitable information are outlined below in detail. There one can find in many cases precise descriptions of approaches and basic requirements concerning the proposed evaluation concept for EFVs. The following findings / concepts will thus be described more detailed.

However, there is no common approach available. Some ECO-rankings also include additional vehicle data (e.g. use of recycled and natural materials, noise, availability of start/stop or CO_2 calculator), others also include manufacturer aspects (e.g. availability of Environmental management system).

3.3.2.1. ECO-TEST ADAC / FIA

On behalf of FIA the so-called "Eco-Test" [30, 31] was developed from the German Automobile Club ADAC. It was projected to enable the assessment of the environmental friendliness of new cars. To ensure reproducible test conditions the 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). Within this approach the environmental impact of passenger cars is assessed in two different categories.

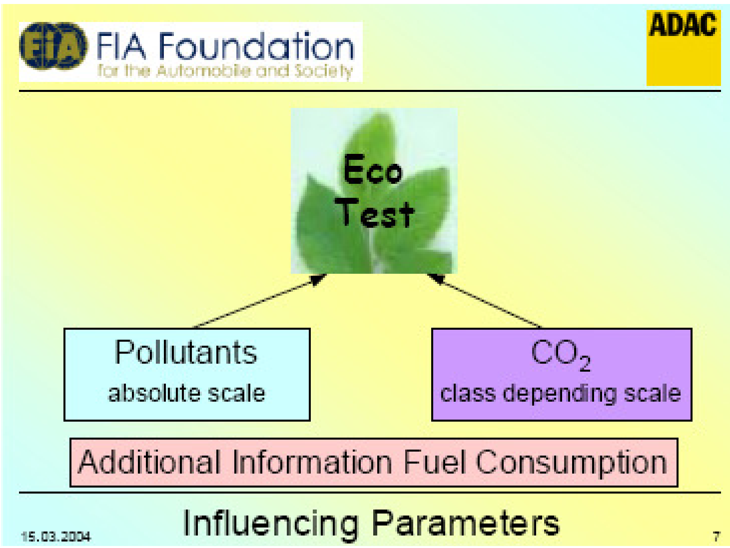


Fig. 3.3.2.1-1: Scheme of "Eco-Test" from the German Automobile Club ADAC.

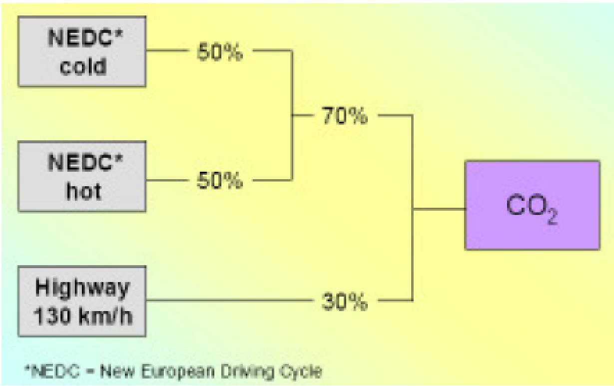
Both categories (limited pollutants on the one side and CO_2-emissions on the other side) contribute with a share of 50 per cent to the overall rating. The Eco-Test awards up to 5 stars, derived from the scores achieved for CO_2 and limited pollutants.

The rating of the CO_2-emissions rests upon relative scales on account of different vehicle classes. This allows a comparison of the results within a certain vehicle class.
Thus consumers have a direct comparing of competitors. 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

Fig. 3.3.2.1-2: Ranking list ADAC.

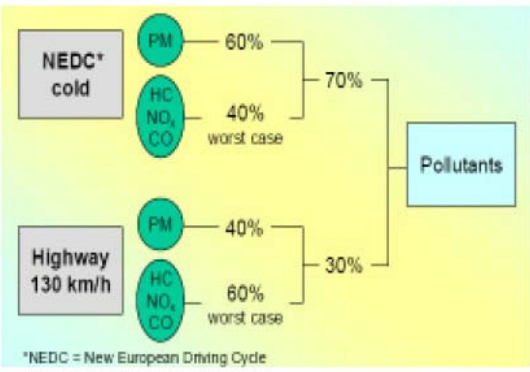
The rating of CO_2 is due to the contribution of the NEDC Cold, NEDC Hot and ADAC Highway results with different weighting factors for the involved cycles and based on seven vehicle classes each with different thresholds.



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

Fig. 3.3.2.1-3: Rating of CO_2 and vehicle classes.

In contrast to the class depending CO_2-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

Fig. 3.3.2.1-4: Assessment of pollutants and vehicle classes.

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 a petrol or diesel engine, 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.

3.3.2.2. VCD

Based on an expert's report of IFEU, VCD [32, 33] publishes a ranking list for cars with regard to environmental concerns. The ranking list called ‚Auto-Umweltliste' is designed to inform the consumers. The Auto-Umweltliste addresses the environmental impact of cars to four different categories with a rating from 0 to 10 points in each case, but the four distinct categories have different shares of the overall appraisal.

The four categories affect:

- CO_2-emissions (with 10 points relating to 60 g/km and 0 points to 180 g/km; share of the overall rating: 60 per cent)
- noise (with 10 points relating to 65 dB(A) and 0 points to 75 dB(A); share of the overall rating: 20 per cent)
- human burden from pollutants (NO_X, NO_2, PM); share of the overall rating: 15 per cent
- impact on the nature; share of the overall rating: 5 per cent

The scoring of the two last mentioned categories complies with the following pattern which strongly depends on the exhaust emission stages Euro 4, Euro 5, Euro 6.

	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

Fig. 3.3.2.2-1: German VCD approach.

With regard to the category 'human burden from pollutants' is has to be mentioned that within this topic the three pollutants NO_X, NO_2 and PM have different weighting factors (NO_X: 25 per cent, NO_2: 25 per cent and PM: 50 per cent).

The applied data were taken from information from vehicle manufacturers.

3.3.2.3. ÖKO-TREND INSTITUTE

Öko-TREND institute [34] awards an environmental certificate for cars. In a holistic approach the assessment is addressed to two focal points i.e. on the one side the evaluation of the vehicle (operation and equipment) which has a ratio of 55 per cent of the overall rating and on the other side the vehicle making and recycling of the vehicle with a share of 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, CO_2-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.

For each criterion within the several categories the vehicle will achieve points. The weighting of the different categories respectively of the criteria varies. A certificate will be awarded, if the total scoring results in more than 90 per cent of the overall points.

Fig. 3.3.2.3-1: German Auto-Umwelt-Zertifikat, Öko-Trend approach.

3.3.2.4. J.D. POWER

The J.D. Power Green Efficiency Rating (a 5-star-rating) [35][2] is based on an ″Automotive Environmental Index (AEI)″, which combines information from the Environmental Protection Agency (EPA) and consumers data (voice-of-the-customer) concerning fuel economy, air pollution and greenhouse gases. The top 30 environmentally friendly vehicles are listed.

3.3.2.5. ENVIRONMENTAL TRANSPORT ASSOCIATION (UK)

The Environmental Transport Association (ETA) [36][1] offers an annual ″Car Buyers' Guide″.
The Guide ranks the best cars in each class (Supermini, Small Family, Small MPV, City, Large Family, Sports, Executive, MPV, Off road and Luxury), the top 10 cars overall and the ten worst cars overall. The ETA 5-star-rating is based on the factors power (engine capacity), emissions (CO, HC, NO_X, PM and CO_2), fuel consumption (urban cold cycle) and noise.

Furthermore there are top 10 lists for cars with the lowest/highest CO_2 emissions and for cars with the lowest / highest fuel costs available. The result of each car is also displayed.

3.4 GREEN MANUFACTURING

'Green Manufacturing' in this context can be best described as 'sustainable manufacturing'
Can be viewed as:

1. manufacturing a 'green' = sustainable product – this is than linked to eco-innovation
2. the manufacturing itself should be 'green' = a sustainable plant

In our view, green manufacturing is both: producing a green product in a green plant.

Several stakeholders indicate that the business case for green manufacturing should first be established, the economic framework, base on a number of possible policy instruments, such as:

- norms & standards,
- taxes & charges
- subsidies & incentives
- trading certificates
- education & training
- public & private partnerships (subsidizing capital expenditures)
- voluntary agreements
- technology transfers
- information, advisory services
- eco-labeling, consumer advise
- green public procurement
- corporate reporting
- environmental management system

These instruments could be reflected in a number of indicators.

[2] The sources [35] and [36] are examples for those kind of findings which are providing only some marginal information. And with respect to findings in the internet in many cases more precise descriptions about the applied ranking method or about the criteria how the assessment of the cars is performed are not specified on the web-sites or in the following links related to the starting point. To get more information about the applied ranking methods considerably more effort would be needed and it is not clear if it is worth the effort involved.

Indicators for sustainable manufacturing:

- The concept of “sustainable manufacturing” seemed not commonly used by European manufacturers. Some participants considered it to cover only factory/facility-level processes. It was shared that clear mapping of the scope applied for particular measurement is needed when developing sustainable manufacturing indicators.
- The measurement used at factory/facility level can be useful to compare between factories/facilities within the same company but is difficult to apply for external benchmarking due to many factors that influence performance. There was a suggestion that the OECD could provide an indicator set for internal manufacturing process improvement together with a collecting of best practice examples.
- On the other hand, product-based or per-unit (not absolute-level) measurement can be applied for comparison of performance between companies and encourage further improvement and innovation as far as the common benchmark methodology is established (e.g. EU energy level).
- It was shared that LCA is useful for comparing between old and new products within the same company but has to be used correctly for external comparison since its calculation depends on scope and many other factors (e.g. manufacturing processes and use materials). However, participants recognised that more needs and pressures for some performance benchmarking are expected in the near future.
- It was also shared that the measurement should not focus only on CO_2 but also take into account other environmental aspects, such as other emissions, chemical use, waste and energy, with balance.

Eco-innovation for green product manufacturing is also linked to eco-efficiency.
Eco-efficiency of the manufacturing process (material production + assembly).
Energy, GHG emissions, resource efficiency all contribute to eco-efficiency.

There is a need for a broader view on green manufacturing of a green product in a green plant. One must look at greening the whole value chain.
This is the only way to move to a low carbon society (a vision the UK government wishes to follow).

In a recent EC/OECD industry focus group on sustainable manufacturing and eco-innovation the following comments where made on the role of government and international institutions.

The role of government and the OECD:

- There was a shared concern over the capability of suppliers for delivering sustainable components as the supply chain of automotive manufactures is very complex. The automotive industry is working to fill this gap, for example, by developing a guideline for understanding the EU´s REACH directive. The government should help educate suppliers and improve their capability from the viewpoint of competitiveness. A good example of this kind is the Green Suppliers Network established by the US Environmental Protection Agency.
- Some participants expressed that certain environmental regulations my create unintended consequences or do not encourage investment in new technologies – e.g. the EU´s Emission Trading Scheme (ETS) sets the targets of CO_2 reduction at the absolute level and does not consider different capabilities of companies to make further reduction, while excluding certain industries from the regulation. In other case, there are several regulations that aim the same objective. They argued that there is a need to streamline the existing

regulations and to keep the regulations simpler and flexible ("outcome-based") based on consistent long-term visions/targets if the government would like to promote eco-innovation. The OECD could take a role in this area.

- There was a call for harmonising environmental regulations, certifications schemes, planning regimes and their implementation/enforcement between regions and countries as it will reduce the costs for environmental investment for companies operating in different countries. The definitions of same basic terminology should also be harmonised – e.g. "waste" can be used as new input in another company/country and the current definition does not encourage reuse and remanufacturing.
- It was suggested that eco-innovation can spontaneously if it makes economic sense. The government should help companies build up business cases for investing in innovation with a longer payback and capital allowance differentiation for green technologies.
- It was also pointed out that commitment of top management is very critical and there is a need to change their mindsets as they tend to focus too much on risk avoidance. The OECD could set a stage for shifting the course of the global debate – e.g. from CO_2 to resource efficiency.
- The government should show examples by themselves first, for example, by implementing green public procurement more thoroughly. The OECD could start from a mapping of the current policy instruments for promoting eco-innovation and benchmark governmental policies and performance.
- The importance of improving consumer awareness, especially about intangible environmental impact of products and their usage, was also emphasised in terms of facilitating sustainable manufacturing and eco-innovations.
- It was shared that there is a need to investigate the processes by which eco-innovation happens and is successfully marketed more depth so that right levers could be identified.

4. ASPECTS FOR THE DEVELOPMENT OF AN EVALUATION CONCEPT (HOLISTIC APPROACH)

4.1. EXPLANATORY INTRODUCTION

Chapter 3 showed a lot of options to define and evaluate vehicles. However it needs to be assessed whether these approaches can be used for the development of a holistic evaluation concept. This assessment needs to first define the foreseen target groups and their purpose(s) in evaluating whether a vehicle concept can be called something close to "environmentally-friendly" – Considering also the words of caution provided by ISO 14021 actually prohibiting this terminology in claims it is indispensable to check whether all relevant environmental aspects are considered – or not (see chapter 4.2.1).

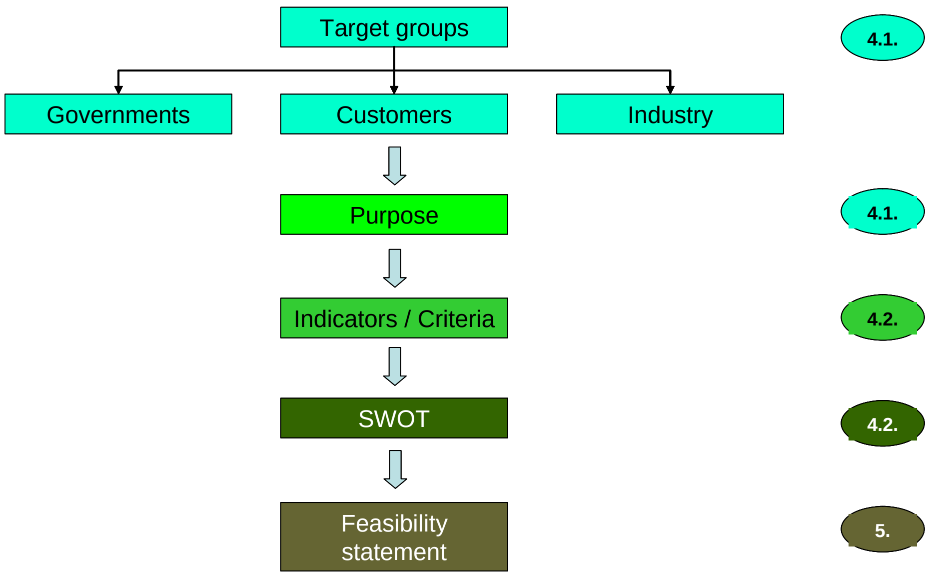


Fig. 4.1-1: Steps of the assessment of the feasibility to introduce an EFV concept.

The target groups are important to assess whether a method is suitable from their perspective. Therefore, chapter 4.4 tries to identify **s**trengths, **w**eaknesses, **o**pportunities and **t**hreats (SWOT) looking from their perspective. These target groups are also defining the purposes why vehicle should be differentiated between "environmentally friendly" ones and those being not "environmentally friendly". The following potential target groups could be identified together with their purposes:

- Supra-national and national governmental bodies governments
  Purpose: - Regulation, fiscal systems
  - Information systems for e.g. public and private procurement
- Customers
  Purpose: - Information systems for purchasing decision
- Automotive industry
  Purpose: - Design specifications

4.2. CRITERIA

- In a first step it will be analysed what environmental aspects (4.2.1.) are covered by the different regulations, concepts and tools provided in chapter 3.
- Additionally the tool evaluation criteria (4.2.2.) will help to describe the dimensions and applicability of regulations, concepts and tools.
- In a second step the SWOT analysis (4.3.) is used for every regulations, concepts and tools to develop a basis for the final feasibility assessment.

4.2.1. POSSIBLE ENVIRONMENTAL ASPECTS COVERED

- Air emissions: CO_2
- Air emissions: regulated pollutants
- Air emissions: other GHG
- Other pollutants: water (yes/no);
- Other pollutants (e.g. waste streams): land (yes/no);
- Use of:
  - materials/resources (recycled, renewable, non-renewable);
  - energy resources (e.g. fossil fuels);
  - water;
  - land;
- Recyclability;
- Toxics (health effects);
- Noise;
- EMC;
- Effects on biodiversity and sustainability.

4.2.2. TOOL EVALUATION CRITERIA

- Data (regional / worldwide):
  - Availability of data;
  - Quality of data;
  - Data is available to whom? Can data be ensured reliable of good quality at world/regional level?
  - Frequency of data updating;
- System boundaries (to the point, solely):
  - Tailpipe;
  - Usage of vehicle; (incl. evap emissions etc.);
    means all inputs (e.g. fuel consumption) and emissions which are caused during the usage of the vehicle (excluding production and disposal). The production of energy for moving the vehicle in service (e.g. fuel production) is normally also included.
  - Production (vehicle, spare parts, fuel, other materials);
    means all processes from the extraction of raw materials or energy resources respectively the growth of renewable materials to the material, part production and final vehicle assembly including all good transport processes between these processes.
  - End-of-Vehicle-Life;
    means all processes from the pre-treatment of the End-of-Life Vehicle (ELV) to the shredding and post-shredder treatment. It includes all processes for recycling, (energy) recovery and disposal of the various fractions.

- Holistic (lifecycle & integrated approach);

- Application:
  - For specific vehicles;
    (Specific vehicle is a variant of a vehicle model where the engine, body style, option package is defined)
  - Vehicle categories
  - Vehicle model (e.g. Opel Astra, VW Golf, Ford Fiesta, Peugeot 308...)
  - current vehicle technology;
  - future vehicle technology;
  - other parts/systems (e.g. MAC’s, tyres, GSI, TPMS, ...);
  - interface: surface, infrastructure;
- Evaluation context:
  - global environmentally impacts;
  - local environmentally impacts;
  - short term impacts;
  - mid term impacts;
  - long term impacts;
  - absolute versus segment-based evaluation
    (Method provides an evaluation based on an absolute or segment-based (relative) scale. An absolute scale would result for example in ‘49392 MJ energy use’ while a segment-based result would refer that to the vehicle segment in stating e.g. ‘3 % lower energy use than average mid-sized cars in India’).
- Effort for application:
  - Time/cost;
  - Self declaration, independent 3rd party review;
  - User expertise;
  - Communication;

4.2.3. APPLICATION OF TOOL EVALUATION CRITERIA

In this table the „regulations and standards, concepts and tools" are compared to different criteria, which are evaluated by using a colour scheme. The criteria were grouped to certain topics („Environmental aspects covered", „Data", „System boundaries", „Application", "Evaluation context" und „Effort for application").
Some of the „regulations and standards, concepts and tools" are combined concepts (e.g. "Green vehicles" and "vehicle rankings") which consist of several concepts.
To evaluate the „regulations and standards, concepts and tools" there are different colours available.
The colour green, respectively "**yes**" means, that the „regulations and standards, concepts and tools" fulfil the conditions which are listed under the groups „Environmental aspects covered", „System boundaries" and "Evaluation context". Red respectively "**no**" means, that the criteria were not fulfilled.
To assign the colour yellow, respectively "**partly**" there are two options.
Example 1: One can use yellow if not all of the criteria have been achieved. This case one see at „Recycling and substance restrictions" and „Use of materials", because there are only a few materials considered but e.g. not renewable materials.
Example 2: One can use yellow to differentiate the combined concepts (e.g. „Green vehicles" and „vehicle rankings"). If there's a criteria that is considered only by one concept (China Green vehicles for example uniquely considers the criteria "Noise") so the field has to set on yellow.
The criteria group "data" is divided into "**low/regional**" and "**high/worldwide**" instead of yes and no. Low means in this case, that the „regulations and standards, concepts and tools" insufficiently fulfil the conditions of the criteria group "data" or if this does not apply on a global scale. An example is the lack of LCA data for each region in the world that would be important looking at the global supply chains in the automotive sector. High means, that the criteria are fulfilled sufficiently. An example is the data availability for recyclability based on the International Material Data System (IMDS). There is also the possibility to choose "**partly**" if for example the quality of data for LCAs or WtW is for some processes good and for others less adequate.
The group "Application" was divided into "**applied**" and "**not applied**", in which the "regulations and standards, concepts and tools" are either applicable or not applicable to the single criteria. For example, vehicle rating systems are normally not applied to future vehicle technologies while recycling and substance restrictions cover also future technologies.
In the last group „Effort for application" one can choose between 5 different colours (**very high**, **high**, **neutral**, **low**, **very low**), to evaluate the „regulations and standards, concepts and tools" on the basis of the single criteria. The differentiation in more ratings than for the other groups is necessary to better understand the substantial difference in effort decreasing e.g. from LCAs (highest effort) to WtW (considerably high effort), recyclability calculations to easier vehicle ranking approaches.

Based on the definition given in chapter 2.8. and 4.2. regulations and standards are analyzed:

	regulations and standards, concepts and tools														
Data from chapter 4.2.1	CO_2 regulations, fuel economy (MAC, CAFE)	fuel directives	Top runner	regulated pollutants	Green Public Procurement	Green vehicles (EPA, Australia, China, Sweden)	noise *regulation related to vehicles*	recyclability ISO 22628	Recycling and substance restrictions	interior air quality	LCA / ISO 14040/44	WTW	vehicle rankings e.g. VCD, Ökotrend	green manufacturing (only production process)	Life Cycle Cost - Externalities (GPP)
Environmental aspects covered: no - partly - yes															
Air emissions:CO2	yes	yes	yes	no	yes	yes	no	no	no	no	yes	yes	yes	partly	yes
Air emissions: regulated pollutants	no	yes	partly	yes	yes	yes	no	no	no	no	yes	no	yes	partly	yes
Air emissions: other GHG	partly	yes	no	partly	no	no	no	no	no	no	yes	no	no	partly	no
other pollutants: water (yes/no)	no	partly	no	no	no	no	no	no	yes	no	yes	no	no	partly	no
other pollutants (e.g. waste streams): land (yes/no)	no	no	no	no	no	no	no	no	yes	no	yes	no	no	partly	no
Use of materials/resources (recycled, renewable, non-renewable)	no	yes	no	no	no	no	no	no	partly	no	partly	no	partly	partly	no
Use of energy resources (e.g. fossil fuels)	no	yes	partly	no	partly	no	no	no	no	no	yes	no	no	partly	partly
Use of water	no	partly	no	no	no	no	no	no	no	no	yes	no	no	partly	no
Use of land	no	partly	no	no	no	no	no	no	no	no	partly *	no	no	partly	no
Recyclability	no	partly	partly	no	no	partly	no	yes	partly	no	no	no	no	partly	no
Toxics (health effects)	no	yes	no	no	no	no	yes	no	yes	yes	partly *	no	no	partly	no
Noise	no	no	partly	no	no	partly	yes	no	no	no	partly *	no	yes	partly	partly
EMC	no	no	no	no	no	no	no	no	no	no	no	no	no	partly	no
Effects on biodiversity and sustainability	no	yes	partly	no	no	no	partly	no	no	no	partly *	no	no	partly	no

* method currently not suitable

	regulations and standards, concepts and tools														
Data from chapter 4.2.2	CO_2 regulations, fuel economy (MAC, CAFE)	fuel directives	Top runner	regulated pollutants	Green Public Procurement	Green vehicles (EPA, Australia, China, Sweden)	noise *regulation related to vehicles*	recyclability ISO 22628	Recycling and substance restrictions	interior air quality	LCA / ISO 14040/44	WTW	vehicle rankings e.g. VCD, Ökotrend	green manufacturing (only production process)	Life Cycle Cost - Externalities (GPP)
Data: low/regional - partly - high/worldwide															
Availability of data regional															
Quality of data regional															
Flexibility/Frequency of data updating regional															
Availability of data worldwide/applicability															
Quality of data worldwide/applicability															
Frequency of data updating worldwide/applicability															
System boundaries: no - partly - yes															
Tailpipe															
Usage of vehicle (incl. evap emission etc.)															
Production (vehicle, spare parts, fuel, other materials)															
Recycling															
Holistic (lifecycle & integrated approach)															
Time horizon: not applied - partly - applied															
current vehicle technology															
future vehicle technology															
Application: not applied - partly - applied															
For specific vehicles															
A generic vehicle application															
Vehicle model															
other parts/systems (e.g. MAC´s, tyres, GSI, TPMS, ...)															
interface: surface, infrastructure															
Evaluation context: no - partly - yes															
global environmentally impacts															
local environmentally impacts															
short term environmental impacts											*				
mid term impacts															
long term environmental impacts															
Segment-based															
Effort for application/Accuracy: very high - high - neutral - low - very low															
Time/cost															
Self declaration, independent 3rd party review															
User expertise															
Communication															

4.3. SWOT ANALYSIS

OICA [37] submitted a paper how to analyse the different approaches concerning the assessment of EFV. The conceptual idea of OICA rests upon the so-called SWOT analysis. The idea of this conception depends on the four issues: **S**trength, **W**eakness, **O**pportunity and **T**hreat which should be taken into consideration when various approaches with regard to the assessment of the environmental friendliness of vehicles are analysed.

Different evaluation methods from the table above are investigated and analysed by means of the SWOT methodology.

It is necessary to clarify the target group of an EFV concept when defining whether something is a strength or a weakness. For example, a very data-intensive method resulting in complex figures might be appropriate and thus a strength for experts while consumers would prefer an EFV concept that is intuitively understandable. At the moment the fundamental discussion about the target groups (governments, industry, consumers) of the evaluation concept and the allocated purposes isn't finalized. But the conclusions of that discussion is needed as basis to perform the SWOT analysis. Based on the decision of GRPE in January 2009 it is assumed that either governments and/or consumers could be the target group of an EFV concept looking for an information system.

1) CO_2-regulations:

Strength	In line with current regulations. Adresses one of the most important environmental indicators (climate protection).
Weakness	No EFV definition in itself. Focus of only one environmental aspect (climate protection). Other item e.g. local air quality are not addressed.
Opportunity	Third party certification possible. Can be easily added to other methods.
Threat	Discussion about environmental protection could be reduced to one aspect (climate protection) and other important aspects such as local air quality will be not addressed properly.

2) Fuel regulations:

Strength	In Europe regulation of fuel quality is an accepted approach to define certain fuel parameters that are health and environmentally related. Regulations in many, but not all, world areas follow the example of EU regulations. International standards are also defined in different world regions for traditional hydrocarbon fuels and also for biofuels for the quality of the final blend and also the quality of the blending bio-components. In standards, the fuel characteristics are defined as performance parameters. In the EU, the issue of lifecycle GHG emissions and sustainability will be included in the new (2009) fuel quality directive and the directive on the promotion of renewable energy use. Default values for lifecycle GHG emissions and WTW data is laid down in EU legislation and will be revised in the future as better data is made available.
Weakness	While the EU defines certain fuel parameters according to their health and environmental impact, not all world regions follow that method. Many countries or regions set parameters just as performance specifications (i.e. limits that may be practical to achieve by 'nationalised' oil refining industry). Market fuel quality data and the monitoring of market fuel quality are good in developed markets but not so good in developing markets.

	Fuel quality regulations do not provide an EFV definition in itself -fuel quality regulation provides data that can be used to support the application of an EFV concept.
Opportunity	**S**upport world-wide recommendations (or regulations) for market fuel quality matched to the application of emission standards.

3) Top-runner approach:

Strength	Accepted approach in Japan. Top runner approach sets energy efficiency targets. Involvement of industry in target setting.
Weakness	Not world-wide harmonized. No consideration of cost-efficiency. Compliance with the target is assessed no on product-by product basis, but on a weighted-average basis. Lack of sufficient data in absolute terms such as quantitative information on energy saving achievements. Actual energy use as such as well as the aggregated energy saving effects are not addressed. Therefore, a detailed and quantitative impact analysis is not possible. Moving performance targets leading to confusion for customers. Elaborate procedures for setting standards based on Japanese tradition of close cooperation between industry and government. Uncertain if such is achievable in other cultures. Name- and shame-sanctions only effective in Japan. Top-runner approach only encourages incremental technical improvements, while innovations receive no incentives under this scheme.
Opportunity	Short-term update of top-runner targets against time consuming standards setting.
Threat	Continuous definition update depending on local circumstances will lead to fragmentation. Setting targets for a wide range of complex products with many characteristics can be an administrative burden. Top runner requirements could be unfavourably deemed as trade restrictions in breach of WTO. Negative effect on consumer prices: moving targets result in shorter lifetimes limiting cost distribution of number of vehicles and in time.

4) Regulated Pollutants:

Strength	Based on existing regional standards and test methods a third party verification can be done → easy to communicate.
Weakness	Currently not worldwide harmonized. Substantial regional differences in e.g. fuel quality, market specifics, test procedures, in-use issues, effective time to be taken into account. Future vehicles cannot be assessed as real testing is needed. Covering only limited pollutant issue – thus not a stand-alone suitable to define an EFV.
Opportunity	Support world-wide harmonization of test cycles and procedures based on common fuel quality. Synergetic effects with type approval.
Threat	Complex interactions with other emission sources and atmospheric chemistry with respect to cause-effect studies. Different regional focus of legislation.

Environmental and other NGO's may favour only certain standards with massive technology implications.

5) Green Public Procurement:

Strength	Already in use in European green public procurement. Not technology based. Based on regulated, verified emission data. Easy to calculate. Easy to compare by consumer: single score in Euro.
Weakness	Include a data, which can vary for a one single car: selling cost. Cost for pollutant emission - internalization - is not scientifically agreed. Mixing of impact of emissions both of local and global relevance has no scientific acceptance. Emission measurement standards drive test are different between EU, JP, US, and are not available for all vehicle types. Disconnected from real environmental stakes: single score in Euro. All depending on criteria selection, limit values. Adoption to regional conditions → further market fragmentation. Development efforts on issues out of customer focus (ELV RRR rates).
Opportunity	potential for easier market introduction of cleaner products.
Threat	Other environmental aspect could be added (noise, toxic substances). Regulated data will be public and could be misinterpreted by e.g. consumers, or journalists... Market fragmentation: emission type criteria may vary from one country to another, and in time. Single euro score does not help to educate the consumer on a responsible purchase.

6) Green vehicle certification (EPA, Australia, China, Sweden):

Strength	Transparent, understandable and easy to establish. Mainly criteria that are anyhow in the development focus, legal base. Relating to existing regulations i.e. harmonized with and supporting legislation.
Weakness	All depending on criteria selection, limit values. Adoption to regional conditions → further market fragmentation. Development efforts on issues out of customer focus (ELV RRR rates).
Opportunity	If EFV definition can be globally agreed on the basis of legislation this could foster a global harmonization of legislation.
Threat	Different schemes create market fragmentation.

7) Noise regulation related to vehicles:

Strength	Outdoor noise recognized as a source of pollution of a vehicle, everywhere in the world. Nor global nor long term environmental impacts of Noise on earth sustainability.
Weakness	To improve the global noise performance, noise regulation on vehicles is not sufficient. It should also involve other stakeholders such as: tyres manufacturers, roads and pavements builders, roads and pavements decision makers, infrastructure and city managers, ..).

	High effort for execution related to data update. Data only available on a regional level.
Opportunity	To reveal some cars with a low level of external noise (?), but in contradiction with the recent request from the blind associations asking for minimum noise level of cars for the pedestrians safety….
Threat	High workload and costs for car manufacturers for low benefits on the global environmental impact.

8) Recyclability/Recoverability:

Strength	Calculation is based on world wide harmonized ISO standard (ISO 22628). The evaluation of the recyclability/recoverability quotas is part of the vehicle type approval in Europe (2005/64/EG), other regions follow with similar concepts (China, Korea). It takes design and material properties of new vehicles into consideration and is based on proven recycling technologies. Easy to communicate.
Weakness	No EFV definition in itself / delivers only data that can be used for EFV definitions. It can not reflect the physical processes that will actually be applied to the road vehicles reaching the end of their life. High effort for execution/update but no significant differences in the environmental performance of different recycling/recovery technology variations.
Opportunity	Can be easily added to other methods → suitable for an information system for both target groups (customer and governments).
Threat	Design for Recycling options might be contradictory to other environmental strategies (lightweight design, etc.).

9) ELV Recycling and substance restrictions:

Strength	ELV directive in Europe (2000/53/EC) as an accepted approach to improve recycling and dismantling standards, to prevent waste from vehicles and to limit the use of hazardous substances in vehicles. Regulations in many, but not all, world areas follow the example of EU regulations.
Weakness	No competitive feature for an EFV definition because all vehicles have to comply with legal requirements (e.g. heavy metal ban). Restricted substances within ELV regulation intended to avoid the disposal of hazardous waste, however on a world-wide and full life cycle scale additional national and international regulations for substances need to be considered (chemical law, REACH, etc.).
Opportunity	Increase quantity of recycled material in vehicles and other products, in order to develop the markets for recycled materials, as one possible aspect for an information system.
Threat	Complexity of approaches for different industry products with different exemptions (E/E, vehicle, etc.) will confuse customer.

10) Vehicle Interior Air Quality:

Strength	Based on existing standards and test methods a third party verification can be done resulting in labels used also in other sectors (e.g. textiles, TUeV TOX-PROOF). → easy to communicate.

	Addressing a consumer health issue.
Weakness	Currently not worldwide harmonized. Complex, time consuming and costly testing required and data are only partly readily available. Covering only consumer health issue – thus not as a stand-alone suitable to define an EFV. Future vehicles cannot be really assessed as real testing is needed.
Opportunity	Can be easily added to other methods.
Threat	Toxicity is an evolving topic with steadily increasing knowledge about the impact of substances. In addition, the real consumer health impact is highly dependent on ventilation, vehicle age and other factors not constant during vehicle life.

11) Life Cycle Assessment:

Strength	Already world-wide harmonized standard (ISO14040/44). Comprehensive method covering many important environmental aspects along the whole life cycle (more than WtW).
Weakness	No EFV definition in itself / delivers only data that can be used for EFV definitions. Very high effort for execution / update. Interpretation of LCAs only possible by LCA experts judging details of used approach, data quality and results → no EFV concept for consumers. Questionable whether suitable for general governmental bodies (only where experts available) Often not including infrastructure and integrated approach items. Data only available on a regional level and for generic vehicle applications. Complex database needed that is not globally available. Certain environmental aspects are not covered in an appropriate way (e.g. toxicity, noise, …). Results for the identical vehicle will be different depending on regional assumptions (e.g. for electric vehicles with different electricity grids in India compared to Europe or US).
Opportunity	Third party review to ensure credibility
Threat	Complexity of method will confuse customer who in consequence would ignore the results.

	Common fuel quality enhances application of a world-wide (or regional) EFV concept. Strengthen vehicle requirements for fully compatible biofuels and future fuel quality, i.e. second generation biofuel production pathways. Streamlined WTW approach including the fuel production and distribution chain. Monitoring of market fuel quality and third-party certification of fuel quality.
Threat	National fuel refiners have a big say in political decisions and consequential refinery investment for cleaner fuels. Environmental and other NGOs may favour only certain biomass pathways. Other national and regional policies, e.g. trade and agriculture, will have a high political impact on fuel regulations.

12) Well to wheel approach:

Strength	In Europe accepted approach.
Weakness	No EFV definition in itself / delivers only data that can be used for EFV definitions. High effort for execution / update. Environmental discussion is reduced to one single parameter (Energy/GHG). Well-to-wheel analysis deal with different fuel options instead of EFVs. Data only available on a regional level and for generic vehicle applications. Data based on scenarios relevant to Europe in 2010 and beyond.
Opportunity	Other environmental aspects such as emissions can be integrated. Streamlined Life-cycle Approach (only fuel chain is additionally considered). Third party certification possible.
Threat	High additional expenditure for the inclusion of other environmental aspects.

13) ECO Ranking by Consumer associations (e.g. Öko-Trend, VCD):

Strength	Easy to establish and third party verification. Top Ten results / Labeling. Methods with more than CO_2 and emission standards.
Weakness	Multi Criteria / impact category approach with questionable “scientific” approved weighting. Criteria with less benefit for environment are included, but no WTW / lifecycle-data.
Opportunity	WTW and other items can be included.
Threat	Due to non-suitable and non-scientific method changing criteria and weightings over time → confuse customer, moving development targets.

14) Green Manufacturing:

Strength	Environmental impact categories exist. Legislative requirements for environmental aspects. Accepted approach to improve performance. Positive impact of product life cycle. Positive impact on emission cap & trade.
Weakness	Not clearly defined, scope can be different. Difficult to compare performances with other plants in same sector. No direct link (yet) to the type of vehicle being produced/assembled on the site. Additional green investments have longer ROI.
Opportunity	To further reduce environmental impact. Linked to potential operational cost reductions = cost-efficiency. Image of company can be approved through communication. Support zero-carbon strategy. Decouple green investments from normal capital expenditures – look at net present value.
Threat	‘Green-washing’. Does the consumer care? If not, why invest, in case of cost-disadvantage?

5. ASSESSMENT OF FEASIBILITY TO INTRODUCE AN EVALUATION CONCEPT UNDER THE FRAMEWORK OF WP.29

For an assessment of different EFV-concepts it is necessary to define the target group (fleet customers, private customers, NGOs, public procurement, interested public). GRPE decided for governments and/or customers as target group with the purpose of serving as information system.

Potential target groups	Purpose	Comment	Covered?
Supra-national and national governmental bodies governments	Regulations, fiscal systems	Regulations already in place, specific for certain aspects (emissions, waste), might form the basis for EFV definition but not the other way around.	No
	Information systems for e.g. public and private procurement	Requires comprehensive information to assess future and current vehicle models. Specific vehicle variant is less important.	Yes
	Road charging, access restrictions	Too dependent on local conditions; better directly referring to existing regulations. No harmonisation of local aspects possible.	No
Customers	Information systems for purchasing decisions	Requires easy understandable information for a currently offered specific vehicle variant.	Yes
Automotive industry	Design specifications	Already available (see chapter 3.2.2.4 – very specific for each model. Each manufacturer needs to look for a competitive advantage resulting in different strategies and approaches → harmonisation of designs not reasonable	No

A crucial result based on the GRPE discussion is that such an approach should be used as an information system on a voluntary base. Conversely, this concept can not be a new regulation in particular for the type approval of the vehicles. Therefore, the concept will be based on existing regulations related to environmental matters.

Theoretically, the environmental profile of a vehicle could be based on a wide range of indicators mentioned in chapter 4 (all types of emissions to air, use of materials/water/resources/substances etc.).–But from feasible perspective the different indicators are quite divers and difficult to capture in a one-size fits all approach.

The feasibility study clearly emphasizes these results. The study has analyzed different concepts and methodologies (as the SWOT analysis) for the environmental performance of vehicle. None of the investigated concepts is able to assess and evaluate the environmental performance on a global harmonized level due to the following reasons:

- An aggregation of different environmental aspects to a single score is based on subjective weightings that would lead to arbitrary and confusing changes in definitions.
- The environmental profile of a product has always to be interpreted on the background of different regional and temporal environmental circumstances.
- Data for all environmental aspects are not available and / or are measured in different ways depending on the region or regulations/legislation.

For example, whereas greenhouse gas emissions or material use are addressing the global effect climate change and resource depletion, the other indicators are addressing regional or even specific local effects. Even more, there are fundamental temporal differences within even one indicator. For example, looking at the electricity generation for an electric vehicle even the well-to-wheel CO_2 emission differ between regions (e.g. captured or not in an Emission Trade Scheme avoiding an increase in CO_2 emissions, change in E-Mix over time). This means that the same vehicle driving around a region over a certain time will have a continuously changing environmental profile. This makes a robust definition of an EFV impossible.
The environmental performance of a vehicle would need to be evaluated differently depending on the local and temporal environmental conditions. E.g. the emission standard of a vehicle in a mega-city has another relevance than in areas with a very low load of air pollutants.

Looking at the SWOT analysis (chapter 4.3) all different approaches have remarkable weaknesses. Either the approaches are too simple and/or not comprehensive enough to define an EFV or they are too complicated for the targeted groups and their applications. However, in any case the aggregation of different environmental aspects to a single score is not at all recommended due to the fact that environmental indicators have to be interpreted based on the local or temporal situation and there is no scientifically / technical justification for a set of weighting factors. Also a flexible approach allowing regional modification within a range of globally harmonized weighting factors is not feasible as this could mean local adjustment factors almost continuously changing over time, different from town or area to another leading to lot of confusion and missing stability for any applications.

In consequence, single scores for defining EFVs shall not be used for comparative assertions according to ISO14040 [9, 38] as well as the term ″environmentally friendly″ shall not be used according to ISO 14021.
The reason for this ISO rule is that 'environmentally friendly' is a very comprehensive and bold statement that is not likely to be justifiable looking at all the indicators mentioned in chapter 4. It might be the case that e.g. a vehicle has lower NO_x emissions than another vehicle during its life-time, regarding local air quality. However, 'environment' is much more than NO_x emissions and need to take into consideration also other relevant items as for example CO_2 emissions, other Greenhouse gas emissions, recycling and end-of-life treatment, noise emissions, hazardous substances….
In consequence, a vehicle having lower CO_2 emissions might be identified as a low-CO_2-emission-vehicle but not necessarily "environmentally friendly". ISO requires a specific definition/wording, not a misleading terminology.

Therefore, any approach for an EFV have to assume the following guidelines :

- address clearly the approach as a customer information system on a voluntary base
- ensure a technology- and segment-neutral instead of a technology- and segment-prescriptive approach
- concentrate on already existing legislation and focus on the crucial requirements in order to avoid misleading and an information overloading
- take into account national or regional differentiation in order to reflect local/regional legislation and requirements
- avoid simplification of complex indicators or impacts in a single score
- define a realistic and affordable EFV threshold concept from a customer perspective (a broad share of existing vehicles in all segments)

Additional work shall include the evaluation of the interface between an EFV and an “environmentally friendly infrastructure” (e.g. clean fuels and electricity).

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