Transmitted by the expert from OICA

Working paper No. **EFV-09-03**
(GRPE Informal Group on EFV,
9th Meeting, 15th February 2011)

OICA comments on EFV-08-03

Parameter: CO2 / GHG emissions

Parameter: CO2 / GHG emissions

Reference Documents:
EFV 07-02: CO2 Emissions
GRPE 58-02: Background Document

The problem of climatic change is one of the most serious consequences of the emission of large quantities of CO2 and other greenhouse gases into the atmosphere. Transport in general and road transport in particular constitutes a major share of the CO2 emissions around the world. Vehicles using fossil fuels (e.g. diesel and gasoline) produce CO2 emissions in quantities that depend on the carbon present in the fuel molecule. Globally, the transport sector now contributes 25% of all the CO2 emissions released into the atmosphere. Approximately 80% of those emissions are from road transport

It is largely expected that in near future the demand for fuels will no longer be covered solely by conventional crude oil. In addition there is potential for increased use of Natural gas, Hydrogen, Blends.

Deleted: year 2012

From the findings of the 4th EFV conference it was clear that:

Automotive industry can only provide tailpipe emission data. The question of including well-to-tank (WTT) emissions needs to be re examined as there are many factors which are variable that would potentially be included in calculation, such as (1) depend too much on the specific situation and may even differ from one pump/charging station to the other, (2) change over time and (3) have data problems (availability, uncertainty over the world). In many ways the attempt to determine obsolete calculations could proved misleading and potentially too complex for the purpose of identifying the cleaner technologies.

Therefore for the first stage of implementation of EFV approach the Tank-to-wheel (TTW) GHG emission data to be only considered. The discussions about the role of vehicle as CO2 emitter strongly depend upon the generation of the fuel. For eg: the environmental performance of the fuel cell running on hydrogen produced by solar electrolysis is outstanding. Fuel cells using renewable such as biomass are also almost entirely clean. However both fuel generation techniques are far away from covering today's or future energy demand of the transportation sector. Therefore, the new technologies that are fuel efficient and low polluting should be identified and implemented in use. For eg. Medium term fuel cells running on fossil fuels may become the most important alternative to IC Engine.

The comparison between electric vehicle and I.C. engine vehicle may be partially accounting, if we consider TTW (Tank to Wheel) emissions. In countries like India, Germany, USA, substantial electrical energy is generated by fossil fuels, which have high carbon emissions. However, the generation of electricity and generation of fuels (Gasoline, Diesel, Hydrogen, CNG, and LPG) vary from the country to country. Here, the regional differentiations come in to the picture. The only way to remove this regional differentiation is to consider Tank-to-wheel emissions (TTW), instead of complete Well-to-wheel emissions (WTW), thereby making comparatively a common platform to compare all vehicles.

Deleted: the

While finalizing the parameters and deciding the approach to evaluate the Environmentally Friendly Vehicle, it was discussed and deemed appropriate to replace the term CO2 emission with GHG emissions so as to concentrate on GHG emissions rather than focusing only on CO2 emissions. GHG could include carbon di oxide, methane, nitrous oxide, ozone, HFCs (hydro fluorocarbons) and PFCs (per fluorocarbons). However, as there are no/few data available beyond CO2 it is recommended to focus on CO2 for the time being.

Deleted: IC engine vehicles

Deleted: Hence proper attention is to be given to the GHG emissions ratings.

Electricity Production from different sources in different countries in the world for 2007:

	Fossil Fuels in % *	Hydro in %	Nuclear in %	Others in %
India	72	16	2	10
Germany	62	3	24	11
USA	69	7	18	6
Japan	33	8	28	31
UK	71	1	20	8
Sweden	2	47	45	6

Source: CARMA data table by country, CARMA, 2008

*The fossil fuel fraction in the energy mix combines gas, oil, coal and lignite use.

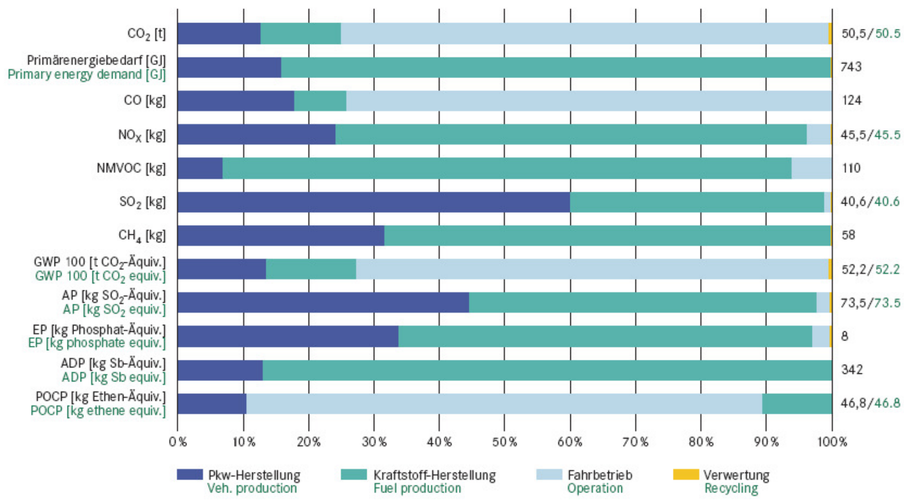
Additionally, the CO2 released during the production is very much less than the CO2 release during the use of vehicle. This is justified from the chart shown below. The chart is the outcome of a LCA study. The vehicle and fuel production only constitutes upto 20% as compared to 80% CO2 emissions during the vehicle in-use phase.

Deleted: belwbelw

Comment [WPS1]: Either we quote all Companies from the background document or none

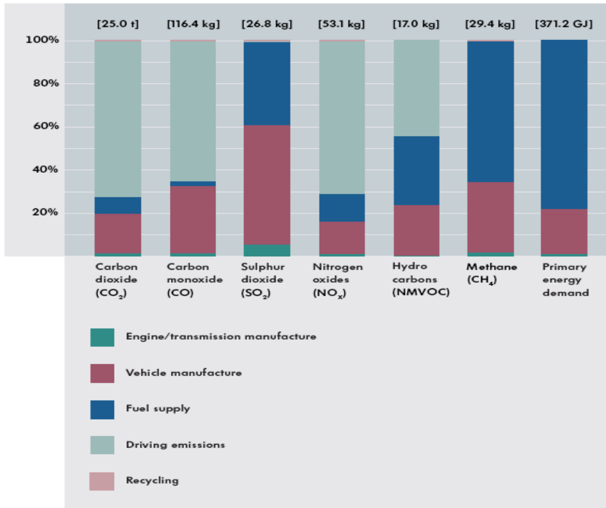
Deleted: Mercedes

Deleted: by Well-to-Wheel Approach



Source: GRPE 58-02 Background document

Deleted: The LCA study by VW is also showing the similar outcome. ¶



Source: GRPE 58-02 Background document

Still, some approaches are given below which accounts for Well-to-Wheel approach. Total 5 approaches are given which are as follows:

1. CO2 Emissions based Rating
2. Fuel Consumption Ratings (Regulation Based Ratings)
3. Fuel Consumption Ratings (Energy consumption)
4. Well – To – Wheel Energy Efficiency

The Current European Test procedure should be followed for testing the vehicles along with the New European Driving Cycle (NEDC) or the World Harmonized Driving Cycle and the Test procedure for the evaluation of passenger vehicle under WLTP can lead to common methodology for the measurement of CO2 along with Regulated Pollutants.

Total 4 approaches for the CO2 are explained below, which can be developed further after the discussions with the committee/group experts.

1st Approach: CO2 Emissions based Rating (regulation based ratings)

CO2 based ratings should be adopted instead of Fuel Consumption Ratings, as fuel consumption quoted in g/km is fuel neutral. The fuel consumption for liquid fuels is km/l while for gaseous fuels it is km/kg. Considering this the CO2 based ratings should be adopted. Additionally, CO2 is an index for both Fuel efficiency and GHG emissions.

The base value for this approach has to been taken different for each region to reflect the specific vehicle needs. In no way any CO2 value should be taken that is derived from a specific vehicle technology. Preferably the rating should be derived from the regional CO2 regulation if applicable. Depending on the region these ratings are either absolute or relative.

Deleted: as 80 g/km

Comment [WPS2]: Picking one vehicle technology is arbitrary. Why is a Hybrid a benchmark? Could be also advanced diesel, plug-in-hybrids etc.

Deleted: emission. This value has been chosen keeping in view the CO2 emissions from Hybrid vehicles. The rating of CO2 is for M1 category of vehicles irrespective of Reference Mass.¶
¶
The vehicle emitting 80g/km or lower will get 100 score

Table 1: example for absolute CO_2 rating

CO2 Emissions in g/km		
From	**Up to and including**	**Score**
<a	-	100
a	b	90
>b	c	80
>c	d	60
>d	e	70
>e	f	50
>f	g	40
>g	h	30
>h	i	20
>i	j	10
`>j	-	0

Deleted: ¶

Deleted: 80

Deleted: 80

Deleted: 100

Deleted: 100

Deleted: 120

Deleted: 120

Deleted: 140

Deleted: 140

Deleted: 160

Deleted: 160

Deleted: 180

Deleted: 180

Deleted: 200

Deleted: 200

Deleted: 220

Deleted: 220

Deleted: 240

Deleted: 240

Deleted: 260

Deleted: 260

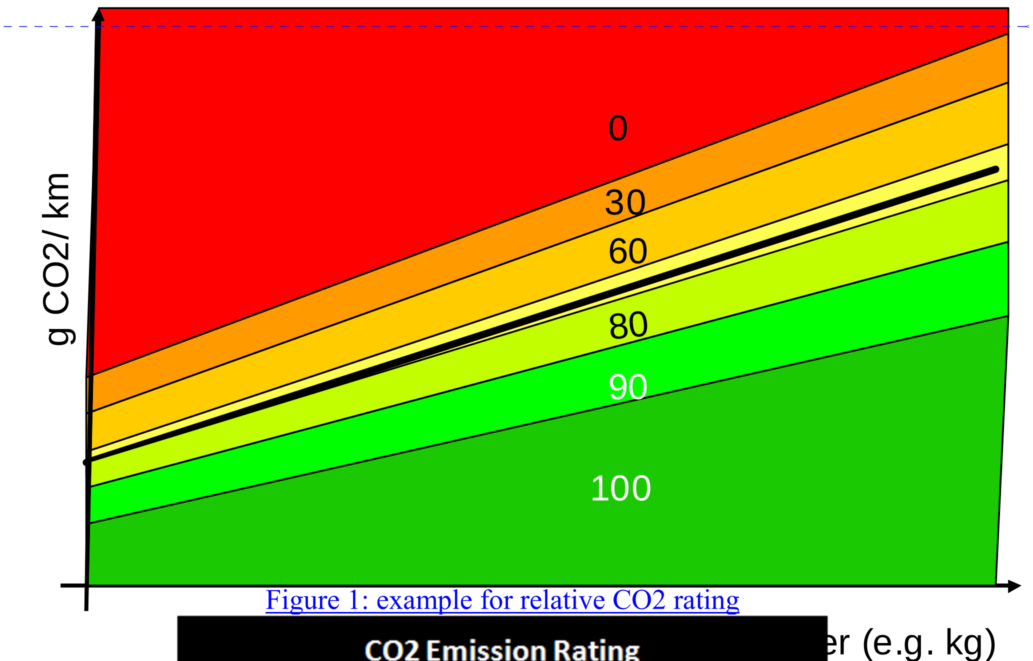
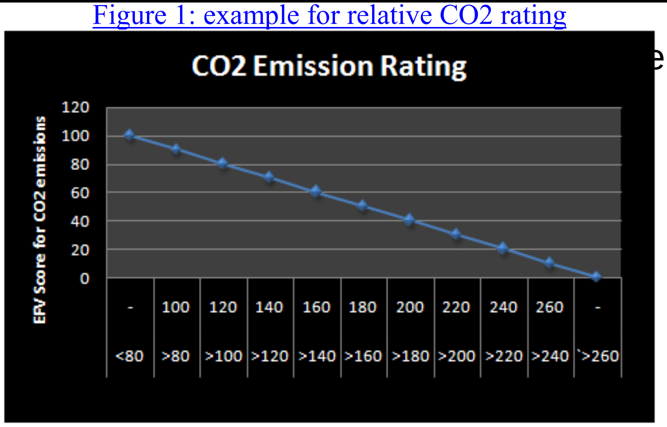


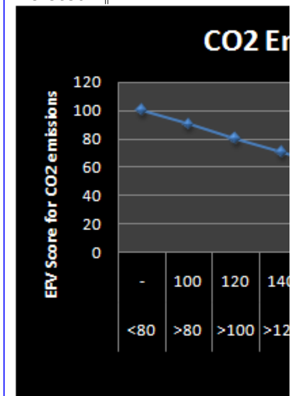
Figure 1: example for relative CO2 rating



Fuel consumption ratings are not technology neutral (diesel vs. gasoline).

Deleted: ¶

Deleted: ¶



¶

Deleted: ¶
2nd Approach: Fuel Consumption Ratings

Deleted: (Regulation Based Ratings)¶
¶
Japan has proposed the future fuel consumption norms, which will be applicable from year 2015 in Japan. The fuel consumption values based on the vehicle mass are stated in the table. The same norms can be used as the criteria for determining the Environment friendliness of a vehicle in terms of fuel consumption.¶
¶
JAPAN CO2 Reduction / Fuel Efficiency Targets:¶
Vehicle weight in Kg and Fuel Efficiency in km/l¶
¶
Gasoline Passenger Cars – Targets from 2010 ... [1]

Deleted: < 702 ... [2]

Deleted: 21.1 ... [3]

Deleted: **Diesel Passenger Cars – Target from 2005** ... [4]

... [5]

... [6]

Deleted: **LPG Passenger Cars – Targets for 2010** ... [7]

Deleted: <702 ... [8]

Deleted: 15.9 ... [9]

Deleted: ¶
Gasoline Passenger Cars – Targets from 2015 ... [10]

2n Approach: Energy Consumption Ratings

Under this approach, the fuel or electricity consumption is converted into the energy consumption, so that the Electric motor and IC engine vehicles can be brought down on a similar platform for comparison.

Energy obtained by burning one liter of	**Gasoline**	**Diesel**	**LPG**	**CNG**
	34.8 MJ	38.6 MJ	25.4 MJ	37-40 MJ/m^3
Density	0.751 Kg/l @ 15 Deg C	0.8342 Kg/l @ 15 Deg C	0.5 kg/l	0.128 kg/l @ 200 bar

Here, the energy content of Diesel is maximum. So, diesel energy content has been considered as a base. Thus, to define the ratings in terms of energy consumption per km run.

Based on the surveys and the analysis conducted over the vehicles to find out the best vehicle in terms of fuel consumption of 22.5 kmpl (which is treated as best fuel consumption) is to be taken as a reference and other vehicle to be rated based on this reference FC.

For Running 1 km of Gasoline/Diesel/CNG/LPG operated vehicle, energy required in MJ

= 38.6 / (Fuel Consumption in km/lit)

For Running 1 km of electric vehicle, Energy required

= Electricity required for running the vehicle in kW-hr/km, which can further be converted to MJ by multiplication of 3.6

Deleted: ≤600 ... [11]

Deleted: 22.5 ... [12]

Deleted: 1531-1650 ... [13]

Deleted: 13.2 ... [14]

Deleted: ¶
Vehicle class ... [15]

Deleted: PC ... [16]

Deleted: Small Buses ... [17]

Deleted: LCV ... [18]

Comment [WPS3]: Covered in example above

Deleted: The approach put forward by the JAPAN will be more suitable as different ratings are suggested for the vehicles with different weight. This approach is also in-line with the future regulations. The vehicle following this norm will be marked with that fuel consumption value and some tax exemptions, incentives should be given for the manufacturing and purchasing of that vehicle.

Deleted: 3r

Deleted: d3rd

Deleted: Fuel

Deleted: (Energy consumption)

Comment [WPS4]: Very questionable whether this is the best fuel consumption in all markets.

Deleted: Based on the surveys and the analysis conducted over the vehicles to find out the best vehicle in terms of fuel consumption, the Tata Nano, Gasoline vehicle has been chosen as a base vehicle. So, the of 22.5 kmpl (which is treated as best fuel consumption of Tata Nano (22.5 kmpl) is to be taken as a reference and other vehicle to be rated based on this reference FC. ¶

Rating	Fuel Consumption in Km/l	Energy consumption in MJ/km	
		From	**To**
100	FC ≥ u	< a	-
80	u ≤ FC < v	a	< b
60	V ≤ FC < w	b	< c
40	w ≤ FC < x	c	< d
20	FC < x	≥ d	-

3rd Approach: Well – To – Wheel Energy Efficiency

- *Gasoline Cars*

The well-to-wheel energy efficiency of a normal gasoline-powered car can be found out by taking gasoline's energy content, which is 34.8 MJ/l , into consideration. Secondly, if we know the efficiency of production of the gasoline and its transportation to the gasoline station, the WTW energy efficiency can be found out as:

A = efficiency of production of gasoline and its transportation to the station,
B = 100 – A = energy content of the crude oil lost to production and transportation

So, C = 34.8 / A will give the energy in MJ of crude oil required to produce one liter of Gasoline at pump.

For eg, a Gasoline powered car with the fuel economy of 20 kmpl, its efficiency will be 20 / C which will give the distance covered by vehicle in one MJ considering Well-to-Wheel energy.

However this efficiency of production of the gasoline and its transportation to the gasoline station vary from nation to nation or even from city to city.

- *Hybrid Cars*

All hybrid cars, except Plug in Hybrid cars, available today have no provision to charge their batteries except by using energy that is ultimately generated by their gasoline engines. This means that they may be considered, from a pollution and energy efficiency perspective, to be nothing more than somewhat more efficient gasoline cars.

Thus a hybrid car with fuel economy of 20 kmpl, this is exactly the same as an ordinary gasoline car that gets 20 kmpl.

The same methodology described in the above part should be used to calculate Well-to-Wheel energy efficiency of a Hybrid car.

Deleted: 22.5

Deleted: 1.715

Deleted: 18.75

Deleted: 22.5

Deleted: 1.715

Deleted: 2.058

Deleted: 16

Deleted: 18.75

Deleted: 2.058

Deleted: 2.4

Deleted: 14

Deleted: 16

Deleted: 2.4

Deleted: 2.74

Deleted: 14

Deleted: 2.74

Deleted: For Example: ¶
¶
A Gasoline vehicle with a Equivalent Inertia Mass of 1250 kg has a Fuel consumption of 14 km/l, and an Electric Vehicle with the consumption of 32 kW-hr / 100 km (115.2 MJ for 100 km).¶
¶
So the energy required to drive one km will be:¶
¶
For Gasoline vehicle = 2.48 MJ / km, will get the rating as 40.¶
For Electric vehicle = 1.152 MJ / km, will get the rating as 100.¶
¶
The criteria for fuel consumption has been chalked based on the fuel consumption values. The fuel consumption value foe Tata Nano is of 22.5 kmpl (which is treated as best fuel consumption) is taken as a base value. So the vehicle having fuel consumption > 22.5 will get 100 score. ¶
The vehicle will get 80 as a score, if the FC value will be between 22.5 and 22.5* 100/ (100-80) = 18.75 kmpl. ¶
¶
The criteria for the energy consumption have been chalked out on the basis of energy content by fuel. The diesel has the highest value of energy content, which is taken as a base value. The energy consumption by the vehicl ... [19]

Formatted

Deleted: 4t

Deleted: h4th

- *Diesel Cars*

Diesel engines works without spark plugs and has higher compression ratios and temperatures than Petrol Engines. This leads to Higher Efficiency of a Diesel car.

The well-to-wheel energy efficiency of a normal Diesel-powered car can be found out by taking Diesel's energy content, which is 38.6 MJ/l, into consideration.
Secondly, if we know the efficiency of production of the diesel and its transportation to the fuelling station, the WTW energy efficiency can be found out as:

A = efficiency of production of diesel and its transportation to the station,
B = 100 – A = energy content of the diesel is lost to production and transportation
So, C = 38.6 / A will give the energy in MJ of crude oil required to produce one liter of Gasoline at pump.

- *Electric Cars:*

One way to produce electricity is with a "combined cycle" natural gas-fired electric generator. (A combined cycle generator combusts the gas in a high-efficiency gas turbine, and uses the waste heat of this turbine to make steam, which turns a second turbine – both turbines turning electric generators.)
If,

Deleted: The most efficient

Comment [WPS5]: Environmental friendliness of renewable electricity is often even significantly higher.

Deleted: ¶

E1 is the efficiency of electric generators
E2 is the efficiency of recovery of the natural gas/ coal/energy source
E3 is the efficiency of the processing of the natural gas/ coal/energy source
E4 is the efficiency of electric grid

So the "well-to-electric-outlet" efficiency 'A' will be E1 x E2 x E3 x E4
B is the energy required to drive the vehicle for 1 km

Then, Well-to-wheel energy efficiency of the vehicle will be B/A

Here also the regional differentiation will play a vital role. The efficiencies of production, distribution, storage will vary from nation to nation, electricity provider to electricity provider.

This approach is only given for information. It should not be adopted, because it is very difficult to find out the efficiencies of the different processes carried out during the extraction, production and transportation of crude oil. The petroleum infrastructure of the specific country could be different from the other. The availability and the authenticity of the data over this approach is also a major concern.

****

Comment [WPS6]: The subject is low CO2 vehicle not low-CO2 manufacturer.

Deleted: However, one option here could be explored that the average CO2 emissions from the all models of a single manufacturer should be calculated and that value should be compared for the rating purpose. This is to give the consideration to manufacturer not only to produce the low weight, small capacity cars but also to look after the comfort, luxury segment. The most suitable approach for CO2 Emissions could be found out through the discussions with the experts.

Deleted: ¶

Page 6: [1] Deleted	Wulf-Peter Schmidt	11/20/2010 3:39:00 PM

(Regulation Based Ratings)

Japan has proposed the future fuel consumption norms, which will be applicable from year 2015 in Japan. The fuel consumption values based on the vehicle mass are stated in the table. The same norms can be used as the criteria for determining the Environment friendliness of a vehicle in terms of fuel consumption.

JAPAN CO2 Reduction / Fuel Efficiency Targets:
Vehicle weight in Kg and Fuel Efficiency in km/l

Gasoline Passenger Cars – Targets from 2010

Page 6: [2] Deleted	Wulf-Peter Schmidt	11/20/2010 3:39:00 PM

< 702	703 – 827	828-1015	1016-1265	1266-1515	1516-1765	1766-2015	2016-2265	2266 - 2500

Page 6: [3] Deleted	Wulf-Peter Schmidt	11/20/2010 3:39:00 PM

21.1	18.8	17.9	16	13	10.5	8.9	7.8	6.4

Page 6: [4] Deleted	Wulf-Peter Schmidt	11/20/2010 3:39:00 PM

Diesel Passenger Cars – Target from 2005

Page 6: [5] Deleted	Wulf-Peter Schmidt	11/20/2010 3:39:00 PM

		≤1015	1016-1265	1266-1515	1516-1765	1766-2015	2016-2265	2266 - 2500

Page 6: [6] Deleted	Wulf-Peter Schmidt	11/20/2010 3:39:00 PM

		18.9	16.2	13.2	11.9	10.8	9.8	8.7

Page 6: [7] Deleted	Wulf-Peter Schmidt	11/20/2010 3:39:00 PM

LPG Passenger Cars – Targets for 2010

Page 6: [8] Deleted	Wulf-Peter Schmidt	11/20/2010 3:39:00 PM

<702	703-827	828-1015	1016-1265	1266-1515	1516-1765	1766-2015	2016-2265	2266 - 2500

Page 6: [9] Deleted	Wulf-Peter Schmidt	11/20/2010 3:39:00 PM

15.9	14.1	13.5	12	9.6	7.9	6.7	5.9	4.8

Page 6: [10] Deleted	Wulf-Peter Schmidt	11/20/2010 3:39:00 PM

Gasoline Passenger Cars – Targets from 2015

Page 7: [11] Deleted	Wulf-Peter Schmidt	11/20/2010 3:39:00 PM

≤600	601-740	741-855	856-970	971-1080	1081-1195	1195-1310	1311-1420	1421 - 1530

Page 7: [12] Deleted	Wulf-Peter Schmidt	11/20/2010 3:39:00 PM

22.5	21.8	21	20.8	20.5	18.7	17.2	15.8	14.6

Page 7: [13] Deleted **Wulf-Peter Schmidt** **11/20/2010 3:39:00 PM**

1531-1650	1651-1760	1761-1870	1871-1990	1991-2100	2101-2270	≥2271		

Page 7: [14] Deleted **Wulf-Peter Schmidt** **11/20/2010 3:39:00 PM**

13.2	12.2	11.1	10.2	9.4	8.7	7.4		

Page 7: [15] Deleted **Wulf-Peter Schmidt** **11/20/2010 3:39:00 PM**

Vehicle class	**2004 Avg. value – km/l**	**2015 Avg. value – km/l**	**Change %**

Page 7: [16] Deleted **Wulf-Peter Schmidt** **11/20/2010 3:39:00 PM**

PC	13.6	16.8	23.6

Page 7: [17] Deleted **Wulf-Peter Schmidt** **11/20/2010 3:39:00 PM**

Small Buses	8.3	8.9	7.2

Page 7: [18] Deleted **Wulf-Peter Schmidt** **11/20/2010 3:39:00 PM**

LCV	13.5	15.2	12.6

Page 8: [19] Deleted **Wulf-Peter Schmidt** **11/20/2010 3:45:00 PM**

For Example:

A Gasoline vehicle with a Equivalent Inertia Mass of 1250 kg has a Fuel consumption of 14 km/l, and an Electric Vehicle with the consumption of 32 kW-hr / 100 km (115.2 MJ for 100 km).

So the energy required to drive one km will be:

For Gasoline vehicle = 2.48 MJ / km, will get the rating as 40.
For Electric vehicle = 1.152 MJ / km, will get the rating as 100.

The criteria for fuel consumption has been chalked based on the fuel consumption values. The fuel consumption value foe Tata Nano is of 22.5 kmpl (which is treated as best fuel consumption) is taken as a base value. So the vehicle having fuel consumption > 22.5 will get 100 score.
The vehicle will get 80 as a score, if the FC value will be between 22.5 and 22.5* 100/ (100-80) = 18.75 kmpl.

The criteria for the energy consumption have been chalked out on the basis of energy content by fuel. The diesel has the highest value of energy content, which is taken as a base value. The energy consumption by the vehicle per km has been calculated as 38.6 / Fuel consumption limits.
i.e. 38.6 /22.5 =1.715. This is how the criteria has been established.

So, from the above example it is clear that the electric vehicle is consuming less amount of energy to drive the vehicle than Gasoline and diesel vehicle. Thus, eacheach vehicle can be compared with reference to the energy required to run the vehicle for one km.