

SUMMARY OF RESULTS

2003 EUROPEAN EMISSIONS TESTING PROGRAMME

Introduction

A €400,000 emission testing programme was commissioned in 2003 comparing the emissions from LP gas, petrol and diesel vehicles.

The vehicles were tested at 4 independent laboratories as follows:

Millbrook Proving Ground, UK
TNO, The Netherlands
IFP, France
TUV, Germany

Twenty-six vehicle fuel systems were tested (20 cars and 6 vans) and these are shown in Attachment I. The vehicles were selected on the basis of being the best available technology in early 2003 (minimum of Euro III on all fuels) and available in equivalent diesel, petrol and LP gas versions. Diesel vehicles were selected as having the nearest equivalent power to the LP gas vehicle and where more than one diesel option was available, the lowest power vehicle was selected. For the total of all vehicles tested the average power for the diesel vehicles was lower than for the LP gas vehicles.

Summary of Results

Vehicles were tested on the European Driving Cycle (EDC) and also the Artemis Cycle (CADC). The latter test better reflects "real world" driving operations as it is a longer test cycle, with a wider range of speeds and performance parameters.

The results are shown in Figures 1.1 to 1.6 and CO₂ is shown for both tailpipe and well-to-wheel as this is a global warming pollutant and is more relevant on a well-to-wheel basis. Factors to adjust tailpipe emissions of CO₂ to a well-to-wheel basis are shown in Attachment II.

The bar charts include the average emissions from all the vehicles that were tested, but individual vehicle results are shown in Attachments III and IV.

In summary, the average results for all vehicles show:

Climate Change

Artemis real-world drive cycle and a well-to-wheel basis:

Petrol CO₂ is 20.3% more than autogas

Diesel CO₂ is 1.8% more than autogas

Air Quality

**Petrol NO_x is 120% to 180% more than autogas,
depending on the drive cycle**

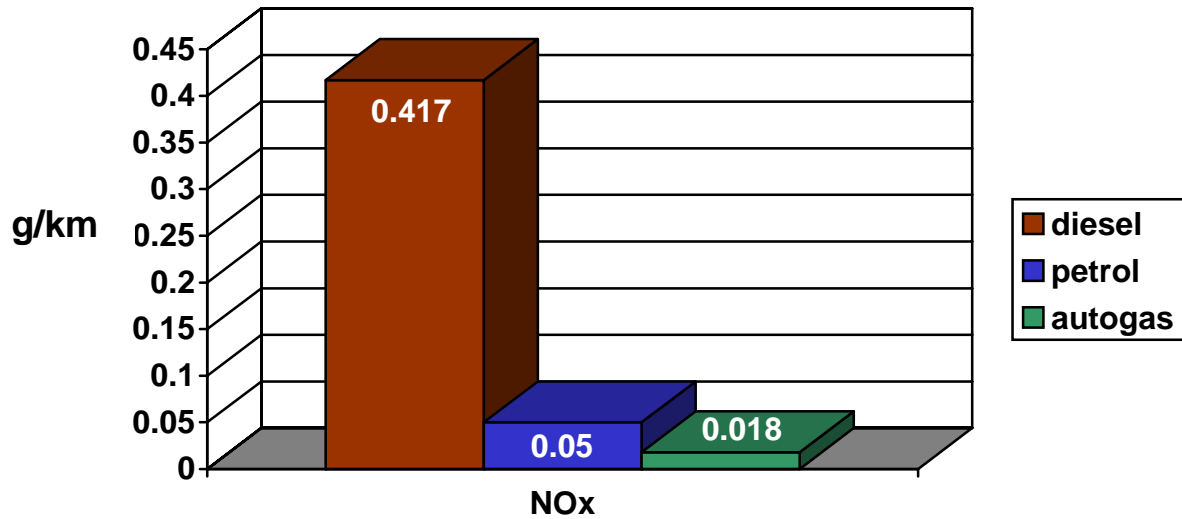
Diesel NO_x is over 2000% more than autogas for any drive cycle

**In other words, one diesel vehicle emits the same NO_x
as over 20 autogas vehicles.**

The tests on fine particles on the urban emission cycle demonstrates that diesel vehicles emit up to 120 times more fine particles than autogas.

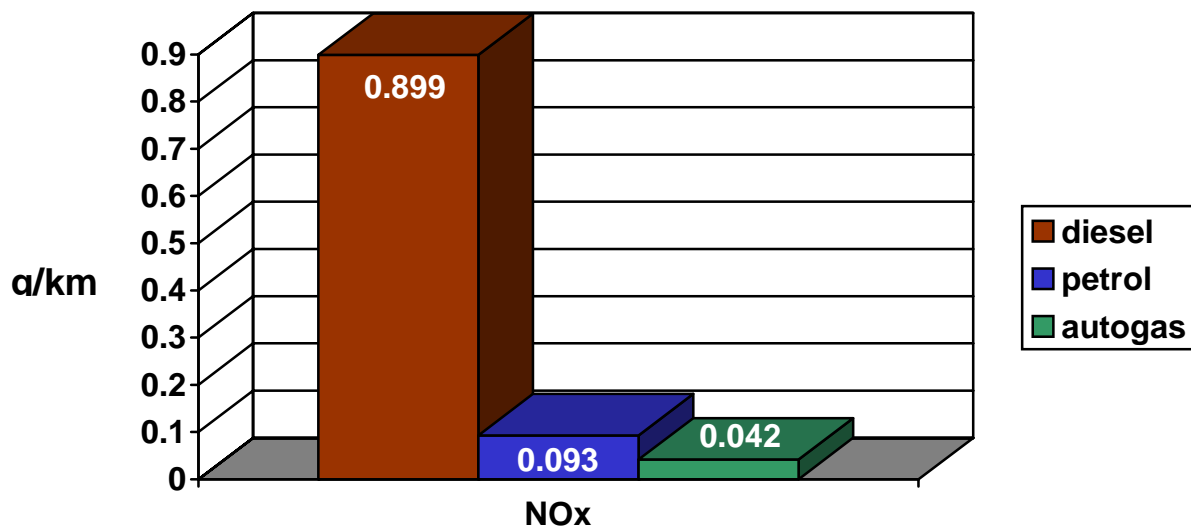
The full report will be available around the end of October. If you would like a copy, please contact the LP Gas Association by telephone on 01425 461612 or via email mail@lpga.co.uk.

Figure 1.1
Average for all vehicles - NO_x on EDC



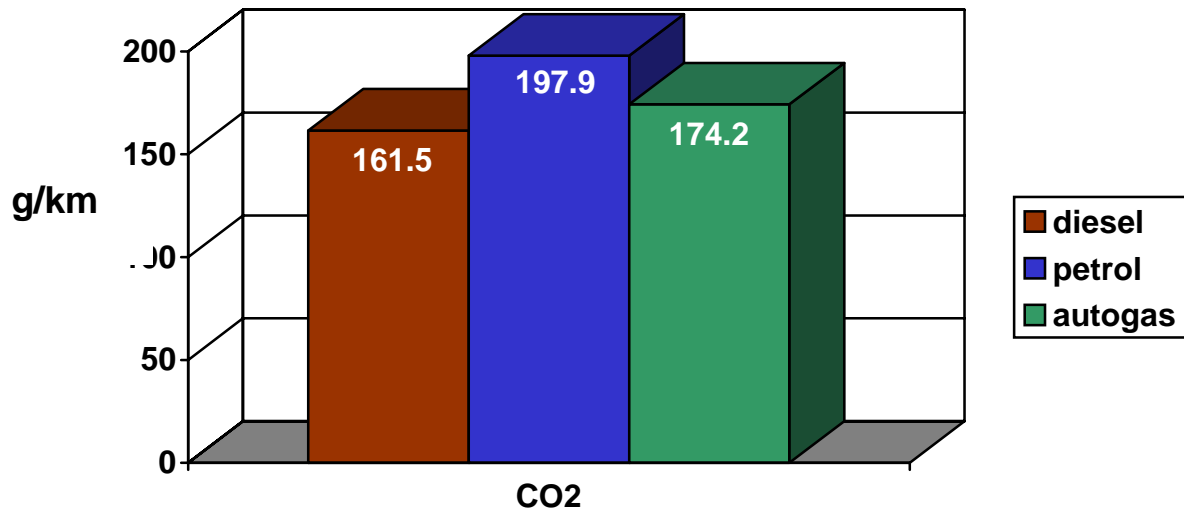
Source: See Attachment III

Figure 1.2
Average for all vehicles - NO_x on CADC



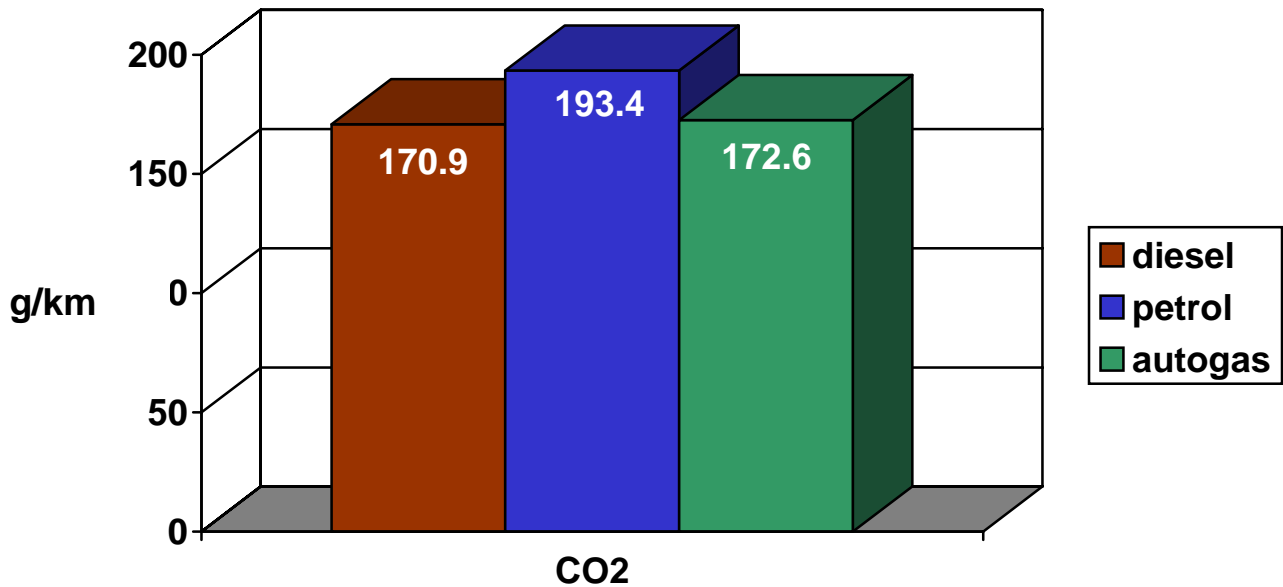
Source: See Attachment IV

Figure 1.3
Average CO₂ emissions for all vehicles EDC - tailpipe



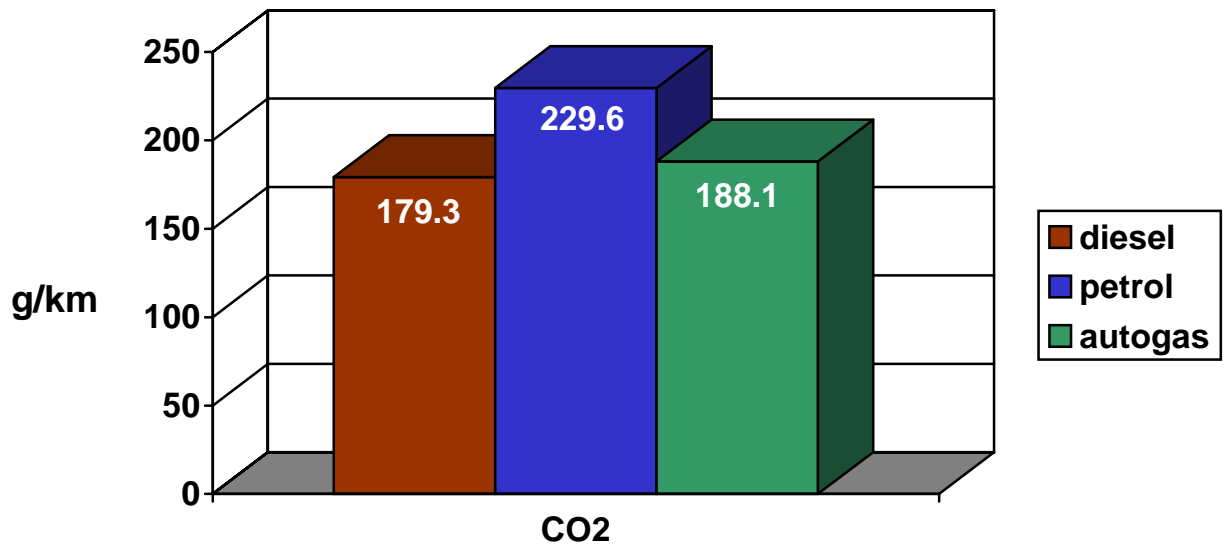
Source: See Attachment III

Figure 1.4
Average for all vehicles – CO₂ on CADC - tailpipe



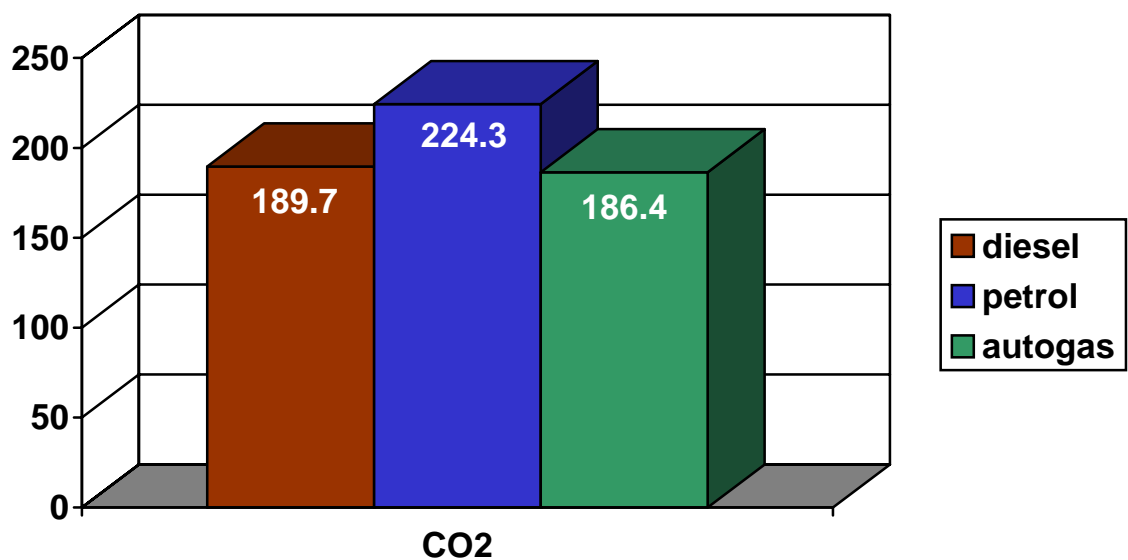
Source: See Attachment IV

Figure 1.5
Average CO₂ emissions for all vehicles EDC – corrected for well to wheel



Source: See Attachments II and IV

Figure 1.6
Average for all vehicles – CO₂ on CADC corrected for well to wheel



Source: See Attachments II and IV

ATTACHMENT I

EUROPEAN TEST PROGRAMME 2003 – VEHICLE DETAILS

No.	Passenger cars	Fuel	Engine Type	Power	Full Test Location	Inertia	Factory fit	Retro-fit	notes
1	Vauxhall Vectra Bi-fuel	Autogas	1.8l 16V 4 cylinder	123	Millbrook	1470	Y		
1	Vauxhall Vectra Bi-fuel	Petrol	1.8l 16V 4 cylinder	125	Millbrook	1470	Y		same vehicle tested as autogas
2	Vauxhall Vectra DTi	Diesel	2.0l 4 cylinder	100	Millbrook	1470	Y		
3	Vauxhall Astra Bi-fuel	Autogas	1.6l 16V 4 cylinder	83	TNO	1360	Y		
3	Vauxhall Astra Bi-fuel	Petrol	1.6l 16V 4 cylinder	85	TNO	1250	Y		same vehicle tested as autogas
4	Vauxhall Astra DTi	Diesel	1.7l 4 cylinder	80	TNO	1360	Y		
5	Peugeot 406 Bi-fuel	Autogas	1.8l 16V 4 cylinder	116	IFP	1360	Y		
6	Peugeot 406 petrol	Petrol	1.8l 16V 4 cylinder	116	IFP	1360	Y		
7	Peugeot 406 HDi	Diesel	2.0 4 cylinder	110	IFP	1470	Y		
8	Renault Scenic Bi-fuel	Autogas	1.6l 16V 4 cylinder	115	IFP	1360	Y		
9	Renault Scenic petrol	Petrol	1.6l 16V 4 cylinder	115	IFP	1360	Y		
10	Renault Scenic DCi	Diesel	1.9l 16V 4 cylinder	120	IFP	1360	Y		
11	Volvo V40 Bi-fuel	Autogas	1.8l 16V 4 cylinder	120	TNO	1470	Y		
12	Volvo V40 petrol	Petrol	1.8l 16V 4 cylinder	122	TNO	1360	Y		
13	Volvo V40 D	Diesel	1.9l 4 cylinder	115	TNO	1470	Y		
14	Volvo V70 Bi-fuel	Autogas	2.4l 5 20V cylinder	140	TNO	1700	Y		
15	Volvo V70 petrol	Petrol	2.4l 5 20V cylinder	140	TNO	1700	Y		
16	Volvo V70 D5	Diesel	2.4l 5 20V cylinder	163	TNO	1700	Y		
17	Peugeot 307	Diesel	2.0l 16V 4 cylinder	110	TUV	1590	Y		not reported to UK
18	Volvo V70 CNG	CNG	2.4l 5 20V cylinder	140	TUV	1700	Y		not reported to UK
19	Nissan Primera Bi-fuel	Autogas	1.8l 16V 4 cylinder	116	TUV	1360		Y	
19	Nissan Primera Bi-fuel	Petrol	1.8l 16V 4 cylinder	116	TUV	1360		Y	same vehicle tested as autogas
20	Nissan Primera 2.2D	Diesel	2.2l 4 cylinder	126	TUV	1470	Y		
Vans									
21	Vauxhall Combo Bi-fuel	Autogas	1.6l 8V 4 cylinder	83	Millbrook	1360	Y		
22	Vauxhall Combo diesel	Diesel	1.7l 4 cylinder	85	Millbrook	1360	Y		
23	Ford Transit Bi-fuel	Autogas	2.3l 16V 4 cylinder	140	Millbrook	1930	Y		
23	Ford Transit Bi-fuel	Petrol	2.3l 16V 4 cylinder	140	Millbrook	1930	Y		same vehicle tested as autogas
24	Ford Transit	Diesel	2.4 DI 4 cylinder	123	TNO	1930	Y		
25	Kangoo Bi-fuel	Autogas	1.2l 16V 4 cylinder	60	IFP	1130	Y		
25	Kangoo petrol	Petrol	1.2l 16V 4 cylinder	60	IFP	1130	Y		same vehicle tested as autogas
26	Kangoo	Diesel	1.5l DCi 4 cylinder	55	IFP	1130	Y		

ATTACHMENT II

COMPARATIVE CARBON EFFICIENCIES

	CO ₂ emitted in making & supplying fuel	Carbon content of fuel
Diesel	11%	86.6%
Biodiesel (5%RME)	9%	86.6%
Petrol	16%	86.6%
Autogas	8%	82.5%
CNG	15%	75%
LNG	25%	75%
Hydrogen	>100%	0%

Source: Figures supplied by BP

ATTACHMENT III

EUROPEAN EMISSIONS TEST RESULTS FOR REGULATED COMPONENTS & CO₂ - EDC

NO _x g/km	diesel	petrol	autogas	CO ₂ g/km	diesel	petrol	autogas
R	0.321	0.088	0.034		151.9	185.7	171.6
Y	0.354	0.038	0.007		148.3	166.3	149.6
H	0.344	0.026	0.012		131.7	159.0	138.6
F	0.305	0.015	0.010		155.9	179.9	161.8
E	0.420	0.060	0.040		161.7	197.7	175.4
T	0.450	0.010	0.020		194.4	232.5	210.7
W	0.410	0.010	0.000		138.8	179.6	161.7
C	0.380	0.157	0.015		168.0	183.0	157.3
N	0.740	0.046	0.031		218.3	297.0	256.0
P	0.448		0.007		145.6		159.7
total	4.172	0.450	0.176		1615	1781	1742
Average	0.417	0.050	0.018		161.5	197.9	174.2

ATTACHMENT IV

European Emissions Test Results for Regulated Components & CO₂ – Artemis

	Urban			Road			Motorway			Overall			
NO _x g/km	Diesel	Petrol	Autogas	Diesel	Petrol	Autogas	Diesel	Petrol	Autogas	Diesel	Petrol	Autogas	
R	0.980	0.445	0.075	0.601	0.218	0.048	0.762	0.260	0.095	R	0.724	0.263	0.076
Y	1.136	0.235	0.262	0.681	0.135	0.072	1.000	0.064	0.029	Y	0.896	0.107	0.068
H	0.838	0.064	0.090	0.742	0.043	0.050	1.120	0.031	0.030	H	0.953	0.039	0.043
F	0.733	0.027	0.056	0.567	0.020	0.036	0.783	0.066	0.016	F	0.702	0.045	0.027
E	1.250	0.130	0.140	0.700	0.080	0.030	0.720	0.020	0.010	E	0.765	0.053	0.030
T	1.120	0.060	0.050	0.680	0.030	0.020	1.000	0.000	0.000	T	0.890	0.020	0.010
W	1.020	0.050	0.010	0.610	0.010	0.000	0.600	0.000	0.000	W	0.645	0.009	0.001
C	0.832	0.335	0.045	0.649	0.182	0.111	0.912	0.171	0.125	C	0.807	0.191	0.112
N	0.870	0.000	0.054	0.54	0.018	0.018	2.03	0.196	0.070	N	1.37	0.111	0.049
P	0.874		0.017	0.560		0.007	1.780		0.003	P	1.240		0.006
Total	9.653	1.346	0.798	6.329	0.735	0.392	10.707	0.809	0.377	Total	8.992	0.837	0.421
Average	0.965	0.150	0.080	0.633	0.082	0.039	1.071	0.090	0.038	Average	0.899	0.093	0.042

	Urban			Road			Motorway			Overall			
CO ₂ g/km	Diesel	Petrol	Autogas	Diesel	Petrol	Autogas	Diesel	Petrol	Autogas	Diesel	Petrol	Autogas	
R	250.3	273.0	246.5	142.0	156.4	148.2	151.0	167.8	160.0	R	157.6	174.1	164.3
Y	231.0	254.0	216.3	140.5	144.2	130.6	163.8	176.0	160.8	Y	161.9	172.1	155.2
H	196.8	240.9	210.2	131.7	142.4	122.5	152.7	166.2	144.1	H	149.4	164.9	142.7
F	234.7	290.6	254.2	138.1	148.0	130.6	153.4	163.7	145.4	F	155.8	170.5	150.8
E	246.5	280.0	258.8	153.7	169.4	151.2	170.1	174.0	154.2	E	171.7	182.9	163.6
T	268.2	360.3	315.7	165.0	189.3	180.6	190.3	219.7	194.8	T	188.6	222.3	201.5
W	200.9	268.4	248.5	121.6	155.0	142.5	136.2	159.8	152.9	W	137.2	168.9	158.5
C	247.5	271.4	239.5	157.4	155.8	140.7	179.2	180.3	159.1	C	178.0	180.3	160.3
N	265.6	393.8	364.9	187.7	243.5	200.3	289.2	329.9	290.1	N	249.5	304.5	264.5
P	186.1		241.0	124.2		138.6	179.3		167.7	P	159.7		164.3
Total	2328	2632	2596	1462	1504	1486	1765	1737	1729	Total	1709	1741	1726
Average	232.8	292.5	259.6	146.2	167.1	148.6	176.5	193.0	172.9	Average	170.9	193.4	172.6

ATTACHMENT IV (continued)

	Urban			Road			Motorway				Overall		
HC g/km	Diesel	Petrol	Autogas	Diesel	Petrol	Autogas	Diesel	Petrol	Autogas		Diesel	Petrol	Autogas
R	0.035	0.014	0.020	0.008	0.007	0.004	0.003	0.005	0.007	R	0.008	0.007	0.007
Y	0.021	0.035	0.117	0.011	0.023	0.022	0.004	0.014	0.016	Y	0.008	0.019	0.029
H	0.010	0.016	0.038	0.008	0.023	0.020	0.006	0.017	0.022	H	0.007	0.019	0.023
F	0.016	0.004	0.001	0.010	0.004	0.003	0.006	0.006	0.010	F	0.008	0.005	0.006
E	0.030	0.040	0.070	0.020	0.010	0.000	0.030	0.010	0.020	E	0.030	0.010	0.020
T	0.030	0.010	0.010	0.010	0.000	0.000	0.000	0.000	0.010	T	0.010	0.000	0.010
W	0.030	0.010	0.000	0.020	0.000	0.000	0.010	0.010	0.000	W	0.020	0.010	0.000
C	0.043	0.080	0.025	0.024	0.020	0.009	0.010	0.018	0.019	C	0.018	0.025	0.016
N	0.050	0.010	0.133	0.010	0.002	0.003	0.010	0.015	0.030	N	0.010	0.010	0.030
P	0.017		0.002	0.011		0.003	0.015		0.018	P	0.014		0.011
Total	0.281	0.218	0.416	0.132	0.089	0.064	0.093	0.094	0.152	Total	0.133	0.104	0.152
Average	0.028	0.024	0.042	0.013	0.010	0.006	0.009	0.010	0.015	Average	0.013	0.012	0.015

Overall													
CO g/km	Diesel	Petrol	Autogas										
R	0.001	0.070	0.815										
Y	0.006	0.289	0.359										
H	0.000	0.988	0.939										
F	0.007	0.325	0.620										
E	0.020	0.060	0.700										
T	0.010	0.610	1.670										
W	0.000	3.680	1.160										
C	0.013	2.263	2.972										
N	0.030	0.450	3.490										
P	0.007		0.670										
Total	0.094	8.735	13.395										
Average	0.009	0.971	1.339										