D5.3 Report on monitoring pilot actions

Title: Report on monitoring pilot actions

Document ID: FLEAT_WP5_Final Report

Deliverable 5.3 (Contractual Deadline 31/03/2010)

Date: 31 May 2010

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Status D (Draft), F (Final), RD (Revised Draft): F

Dissemination level PU (public), RE (restricted), CO (confidential): RE

1 OBJECTIVE & CONTEXT

The objective of work package 5 was to monitor the effectiveness of the different measures in reducing CO_2 and reducing mobility demand. In a first stage, a harmonized assessment framework was developed. This assessment framework consists of 3 indicator frameworks that served to measure the effectiveness of the actions in 3 fields: energy efficient vehicles, energy efficient use of vehicles, energy efficient use of fleets. In a second stage, when applicable, the framework was used to monitor the FLEAT pilot actions (see WP4) and to build information on the effect of the measures in real life.

This final report discusses on the one hand the assessment framework, named CO_2-footprint, and on the other the results of the different type of measures and the individual pilot actions.

2 HARMONIZED ASSESSMENT FRAMEWORK

For the 3 types of actions that can be implemented in fleets, a detailed indicator framework was developed to measure the effectiveness of pilot actions. The detailed indicator frameworks were consequently merged in one harmonised assessment framework. This framework is an excel-application which was made available through a dedicated website (http://www.vito.be/CO2-footprint). The harmonised assessment framework also defined the procedure that had to be followed (data to be collected, frequency of reporting,…) for the monitoring of the results of the pilot actions. A manual for the harmonised assessment framework was provided to the FLEAT-partners.
The application of the assessment framework was done in the monitoring of the pilot projects. At the start of the pilot action, a baseline situation was reported to which the results of the pilot action could be compared. Each of the partners that implement the pilot actions were asked to follow the monitoring procedure. The FLEAT partners completed the assessment framework application based on data that have been provided by the fleet operators.

2.1 CO_2-footprint website application

The monitoring framework is available on the following URL: http://wwwd.vito.be/co2-footprint

The introduction page gives every visitor the opportunity to register. This is needed to be able to communicate with the users (eg. send reports by means of the email addresses).

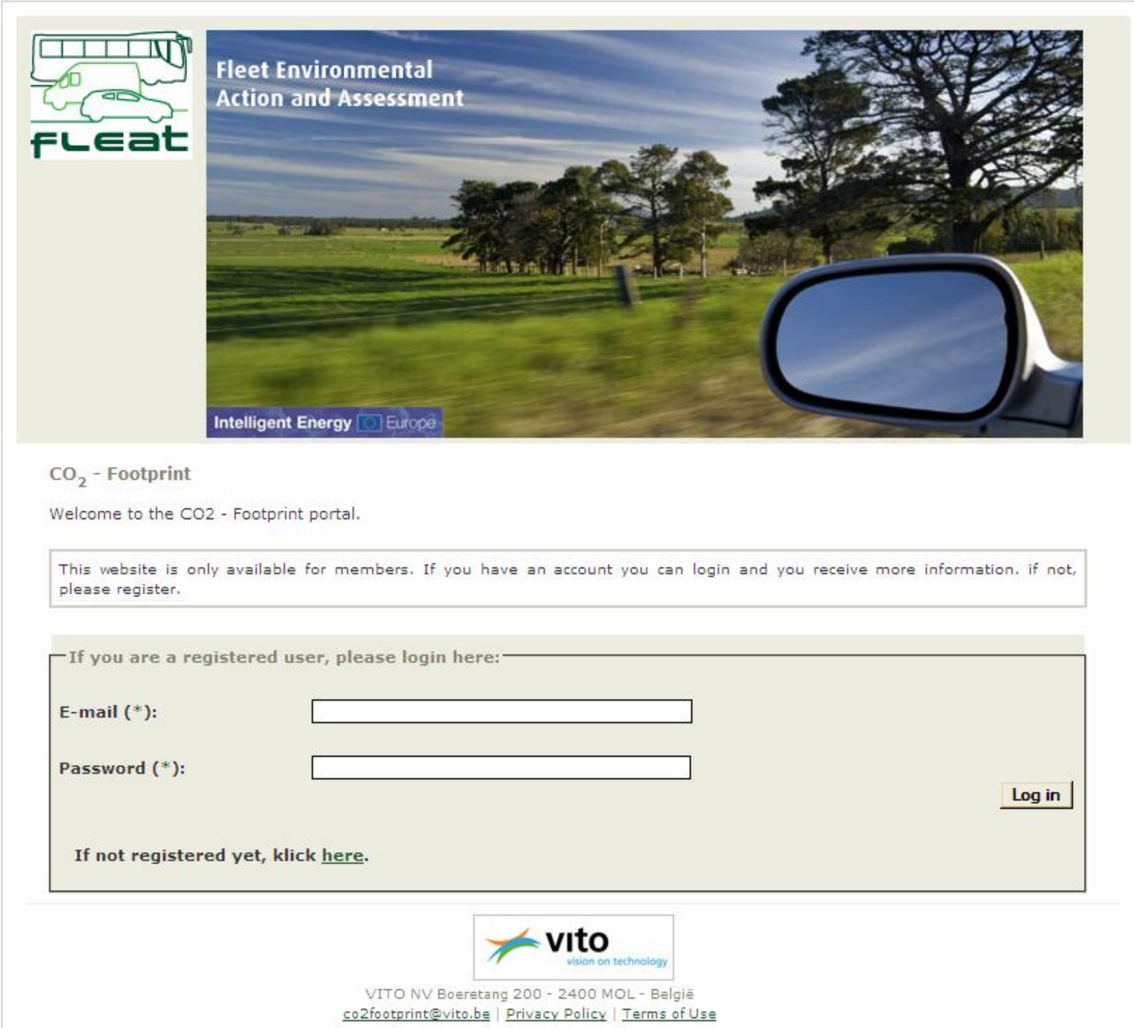


Figure 1. Screenshot of the CO_2-footprint registration page

Once registered and logged-in, you have three possibilities

- template download: by clicking the given link ("Download the template here"), you can download an excel template which is to be used to monitor the pilot action.
- Fleet upload: once the excel file is filled in correctly, this file can be uploaded to the website. All uploaded data will be processed by a VITO server.
- Overview of uploaded files: a list of all successful uploads is shown at the bottom of the page. 2 uploaded and processed files can be compared by clicking the correct files in the "Compare file 1" and "Compare file 2" columns. This generates an additional report, with an overview of the difference between the 2 files. This allows to assess the effect of the implementation of a certain measure.

Users registered as 'administrators' have additional functionalities, such as an overview of all uploaded files, an overview of all registered users, etc.

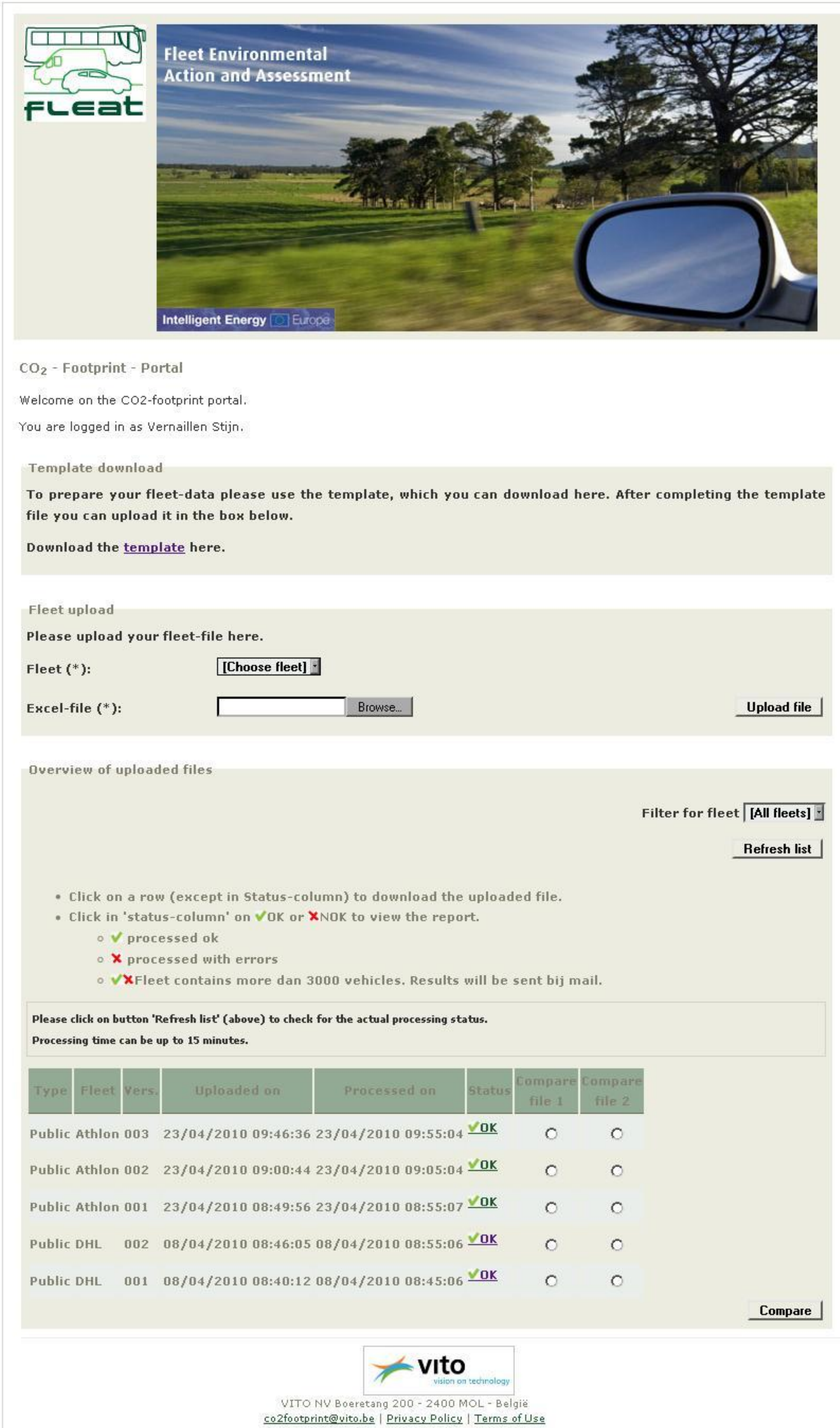


Figure 2. Screenshot of the CO_2-footprint

2.2 Output of the CO_2-footprint

The indicators that are generated are, on the individual vehicle level:

- Passenger cars:
  - Ecoscore: environmental well-to-wheel indicator
  - Total direct CO_2-emission (kg/year)
  - Average direct CO_2-emission (g/km)
  - Total well-to-wheel CO_2-emission (kg/year)
  - Average well-to-wheel CO_2-emission (g/km)
  - Actual vs. official fuel consumption (%)
  - External costs (as stipulated in directive 2009/33/EC)
- Other vehicles:
  - Total direct CO_2-emission (kg/year)
  - Average direct CO_2-emission (g/km)
  - Total well-to-wheel CO_2-emission (kg/year)
  - Average well-to-wheel CO_2-emission (g/km)
  - Actual vs. official fuel consumption (%)

In addition, an evaluation is included for all these indicators. This means that the value of the indicator is compared to the average of the same vehicles in the fleet (++, +, 0, -, --).

The indicators that are generated on the fleet level, are:

- Number of vehicles per vehicle and fuel type
- Average ecoscore, official CO_2-emission, official fuel consumption (passenger cars only)
- Fleet total (l/year) and fleet average (l/100km) fuel consumption per vehicle type and fuel type
- Fleet total (kg/year) and fleet average (g/km) real direct CO2-emission per vehicle type and fuel type
- Fleet total (kg/year) and fleet average (g/km) real well-to-wheel CO2-emission per vehicle type and fuel type
- Fleet total (km/year) and fleet average (km/year/vehicle) mileage per vehicle type and fuel type

The ‘compare’ functionality compares 2 uploaded files of the same fleet in terms of all the indicators listed above.

3 RESULTS FLEAT PILOT ACTIONS

The application of the assessment framework was done in the monitoring of the pilot projects. At the start of the pilot action, a baseline situation was reported to which the results of the pilot action could be compared. Each of the partners that implement the pilot actions were asked to follow the monitoring procedure. The FLEAT partners completed the assessment framework application based on data that have been provided by the fleet operators. In some cases it was not possible to use the CO_2-footprint for the evaluation of the different measures, but for the large majority this harmonized assessment framework was used.

The results of the different pilot actions are discussed in this chapter. The 3 types of measures are discussed separately, and the figures of the individual pilot actions are included in annex.

3.1 Results pilot actions on ecodriving

3.1.1 Ecodriving with light duty vehicles

In this reporting, passenger cars and small vans are considered to be the same type of vehicle (light duty vehicles). Because of the large similarities in vehicle technology for both types, ecodriving principles are very similar.

In total, 9 different fleets implemented ecodriving measures with a total of 809 vehicles involved. Most of the measures in these pilot actions consisted of a typical ecodriving course. First, a trip is made by car where drivers drive the way they are/were used to. Afterwards, a theoretical course on ecodriving is given, followed by the same trip but now applying the ecodriving principles. The difference in average speed, time and fuel consumption is recorded by means of the board computer. Most of the pilot actions also had some sort of follow-up scheme, where drivers were regularly reminded of the ecodriving principles and progress of their fuel consumption was given. We were not able to calculate the result of 1 fleet (KBC, Belgium), since it proved to be too difficult to gather the required monitoring data. However, the KBC fleet manager indicated that he had the impression the expected reduction in fuel consumption was not achieved. The major difference with the other pilot actions was that drivers were simply given an ecodriving course, and no follow-up or feedback scheme was implemented. This is one of the most important conclusions, that is that a follow-up program is essential to achieve a long term reduction in fuel consumption.

Results

For the 6 vehicle fleets of which we had all the necessary data, the results obtained on the longer term proved to be comparable: on average a reduction in fuel consumption and thus CO_2-emission of 6,4% was realised. The minimal reduction was 2,2% (PPP, Greece), and the maximal was 21,8% (Bristol Meyers Squibb, Greece). A total of more than 22 million kilometres were driven on a yearly basis with these 643 vehicles, and due to the ecodriving course, during this year more than 270 tons of CO_2 were saved.

FLEAT partner	Pilot action	Fuel reduction %	Fuel reduction (l/100km)	Number of vehicles	Km / year	Original fuel consumption (l/100km)
CRES	Bristol	-21,8	-2,6	3	21820	12,1
CRES	Leaseplan	-7,2	-0,6	6	20363	8,9
CRES	PPC	-2,2	-0,2	3	12016	9,1
CRES	TNT	-5,2	-0,8	4	33807	15,4
IPA	Helco	-15,8	-1,7	18	19320	10,4
IPA	Isis	-15,6	-1,4	20	22409	9,1
SN	Kone	-6,0	-0,4	576	35852	7,0
AEA	ÖBB	-6,3	-0,5	13	34612	7,6
VITO	KBC	-	-	166	35718	6,8

FLEAT partner	Pilot action	Amount of fuel saved (liter)	Kg of CO_2 saved/year	Total number of vehicles	Potential savings (kg CO_2/year)
CRES	Bristol	-1728	4134	130	179128
CRES	Leaseplan	-782	1870	5000	1558665
CRES	PPC	-72	172	4000	229945
CRES	TNT	-1082	2588	140	90571
IPA	Helco	-5738	14437	22	17645
IPA	Isis	-6364	16012	22	17613
SN	Kone	-86734	228977	576	228977
AEA	ÖBB	-2160	5702	4000	1754413
VITO	KBC	-	-	964	395601
		total	273892	total	4472558

Potential

Many of the pilot actions included only a part of the vehicle or driver fleet, which could be considered as a test fleet. When estimating the potential of ecodriving in these vehicle fleets, we estimate that the same average fuel reduction can be achieved for all vehicles/drivers in the fleet. In addition we supposed that KBC could achieve the same average effect when implementing some sort of follow-up scheme. So the potential effect that ecodriving can have in these fleets is a total reduction of nearly 4.500 tons of CO_2 on a yearly basis.

3.1.2 Ecodriving with trucks

A total of 3 truck fleets with 322 vehicles were involved in the FLEAT-project. The drivers of these trucks were given an extended version of a standard ecodriving course as described in 3.1.1. In 2 of the 3 fleets an intensive follow-up program was implemented, with monthly feedback on the driver's fuel consumption, regular refreshing courses, and even a mentor-program with senior and junior drivers. One of the fleets also had some sort of rewarding scheme, where the most energy efficient drivers were rewarded every month. Whereas one other fleet explicitly did not wish to have such a scheme, since it would create 'unhealthy competition' between the drivers.

Results

The 3 truck fleets achieved very similar results, with average reductions in fuel consumption of 9,4%. A minimal reduction of 8,5% was achieved, and a maximal reduction of 11,4%. With average yearly driven distances of close to 69.000 kilometres, a total of more than 1.900 tons of CO_2 were saved.

FLEAT partner	Pilot action	Fuel reduction %	Fuel reduction (l/100km)		Number of vehicles	Km / year	Original fuel consumption	
VITO	Van Dievel	-9	-2,9	l/100km	80	86805,56	32,0	l/100km
BAUM	Holcim	-8,5	-3,0	l/100km	130	70335,78	35,3	l/100km
AEA	RCA	-11,4	-4,2	l/100km	112	53866	36,9	l/100km

FLEAT partner	Pilot action	Amount of fuel saved		Kg CO_2 saved/year	Total number of vehicles	Potential savings (kg CO_2/year)
VITO	Van Dievel	-200000	liter	528000	80	528000
BAUM	Holcim	-274310	liter	724177	270	1504060
AEA	RCA	-253989	liter	670531	130	778295
			total	1922708	total	2810355

Potential

In one of the fleets, all drivers followed an ecodriving course, where in the other 2 the ecodriving course was limited to a large majority of the drivers. When estimating the potential of ecodriving in these vehicle fleets, we estimate that the same average fuel reduction can be achieved for all vehicles/drivers in those fleets. So the potential effect that ecodriving can have in these fleets is a total reduction of 2.800 tons of CO_2 on a yearly basis.

3.1.3 Ecodriving with buses

A total of 6 bus fleets with 332 vehicles were involved in the FLEAT-project. The drivers of 5 fleets were given an extended version of a standard ecodriving course as described in 3.1.1. One fleet installed a fuel consumption monitoring device in one of their vehicles, and gave feedback to the driver on the basis of the recordings of this device. No ecodriving course was given to the drivers of this bus, but the fact that the fuel consumption was monitored, drivers were stimulated to drive in a energy efficient manner. All of these busses belonged to a public transport company. One of the fleets used electric trolley buses, and one used CNG-busses. The other buses were conventional diesel buses.

Results

The 6 bus fleets achieved quite similar results, with average reductions in fuel consumption of 7,2%. A minimal reduction of 6,3% was achieved, and a maximal reduction of 16%. With a total yearly driven distance of more than 27 million kilometres, a total of 1.680 tons of CO_2 were saved. The result of only giving feedback on the basis of the monitoring device and not giving an ecodriving course, was a reduction of 13,7% in fuel consumption. This again proves that implementing a thorough follow-up and feedback scheme is at least as important as giving ecodriving courses.

FLEAT partner	Pilot action	Fuel reduction %	Fuel reduction (l/100km)		Number of vehicles	Km / year	Original fuel consumption	
BEMAG	Husmann	-13,7	-4,9	l/100km	1	11223	35,5	l/100km
BEMAG	VVV	-6,0	-2,4	l/100km	19	84000	39,0	l/100km
IPA	Craiova	-16,0	-9,8	l/100km	8	112991	61,1	l/100km
SN	Arriva	-6,9	-2,0	l/100km	294	83571	29,0	l/100km
TRT	AVM	-7,2	-3,9	m³/100km	8	34037	54,2	m³/100km
CRES	ILPAP	-9,7	-19,0	kWh/100km	2	20338	195,9	kWh/100km

FLEAT partner	Pilot action	Amount of fuel saved		Kg CO_2 saved/year	Total number of vehicles	Potential savings (kg CO_2/year)
BEMAG	Husmann	-545,4	liter	1440	20	28799
BEMAG	VVV	-37506,0	liter	99016	100	521136
IPA	Craiova	-88404,1	liter	233387	203	5922188
SN	Arriva	-491397,5	liter	1297289	927	4090433
TRT	AVM	-10619,4	m³	28035	350	1226539
CRES	ILPAP	-7728,3	kWh	20403	366	3733718
			total	1679570	total	15522813

Potential

In all fleets where ecodriving courses were given, these were limited to a part of the drivers. When estimating the potential of ecodriving in these vehicle fleets, we estimate that the same average fuel reduction can be achieved for all vehicles/drivers in those fleets. The same goes for the fuel consumption monitoring device, which was only installed in one bus. So the potential effect that energy efficient driving can have in these fleets is a total reduction of more than 15.500 tons of CO_2 on a yearly basis.

3.1.4 Cost effectiveness of ecodriving actions

To be able to estimate the costs and benefits of an ecodriving measure in a fleet, different things have to be taken into account. There is the cost of the trainer, but also the costs of the loss of additional man hours should be taken into account. A course lasts for at least half a day, during which the drivers are occupied, and implementing and maintaining a follow-up and feedback scheme is also time consuming. On the other hand, the benefit should not only be expressed in amount of fuel saved. An energy efficient driving style also has a beneficial effect on maintenance costs, less tire and brake wear, etc., and even on the well-being of the drivers (less stress, ...). However, these benefits are hard to express in monetary value.

Based on our FLEAT pilot actions, we estimate the costs of this type of measure to be between € 300 and € 1.000 per driver. This is including the trainer and loss of man hours, and is independent from the type of vehicle. For reasons explained above, we express the benefits only in terms of fuel savings. By means of a realistic example (i.e. average data from out FLEAT pilot actions), we can calculate the payback period and cost per ton of CO_2 saved for each vehicle type. It is clear that the payback period and the cost per ton of CO_2 is lower for heavy duty vehicles. This is due to the fact that the costs are equal, but fuel savings are much greater in absolute figures.

The cost per ton CO_2 saved is first calculated as the initial cost divided by the amount of CO_2 saved over a period of 5 years. Second, the cost is also calculated taking into account the savings over a period of 5 years due to lower fuel consumption. The last result is displayed as “cost per ton CO_2 saved (overall cost)”.

Light duty vehicles:

	€300/driver	€1000/driver
Average fuel cons	7,2 l/100km	
Average yearly distance	35.000 km	
Total yearly fuel cons	2.520 l	
Fuel reduction with ecodriving	6,4%	
Yearly savings (à 1,2 €/l of fuel)	ca. €200	
Payback period	1,6 years	5,2 years
Cost per ton CO_2 saved (investment cost only)	€140/ton CO_2	€470/ton CO_2
Cost per ton CO_2 saved (overall cost)	€ -314/ton CO_2	€15/ton CO_2

Trucks:

	€300/driver	€1000/driver
Average fuel cons	35,0 l/100km	
Average yearly distance	69.000 km	
Total yearly fuel cons	24.150 l	
Fuel reduction with ecodriving	9,4%	
Yearly savings (à 1,2 €/l of fuel)	ca. €2700	
Payback period	1,3 months	4,4 months
Cost per ton CO_2 saved (investment cost only)	€10/ton CO_2	€33/ton CO_2
Cost per ton CO_2 saved (overall cost)	€-445/ton CO_2	€-421/ton CO_2

Buses:

	€300/driver	€1000/driver
Average fuel cons	30,4 l/100km	
Average yearly distance	82.000 km	
Total yearly fuel cons	25.000 l	
Fuel reduction with ecodriving	7,2%	
Yearly savings (à 1,2 €/l of fuel)	ca. €2150	
Payback period	1,7 months	5,6 months
Cost per ton CO_2 saved (investment cost only)	€13/ton CO_2	€42/ton CO_2
Cost per ton CO_2 saved (overall cost)	€ -442/ton CO_2	€-412/ton CO_2

3.1.5 Conclusions on ecodriving actions

In all but 1 FLEAT pilot actions, we saw significant reductions in fuel consumption after implementing ecodriving measures. The largest effect in terms of relative reduction was seen with trucks (-9,4%), followed by busses (-7,2%) and then light duty vehicles (-6,4%). The payback period is also shortest for trucks, and longest for light duty vehicles. The truck fleets we had as pilot actions in the FLEAT project, were also the fleets with the most intensive follow-up and feedback scheme. The one fleet were the estimated effect was not achieved, was the only fleet where no feedback scheme was implemented. The one fleet where no ecodriving course as such was given, but only a very detailed monitoring procedure was implemented by means of an on board logging device, achieved even better results than average. This leads to the conclusion that a good follow-up and feedback scheme is an absolute necessity for achieving good results when implementing ecodriving measures.

3.2 Results pilot actions on clean vehicles

We had 2 main type of FLEAT pilot actions regarding clean vehicles: car policy modifications for company cars, and the use of CNG-vans instead of conventional diesel or gasoline vans. We had some additional types pilot actions, but they were less in number of vehicles, so it’s hard to draw conclusions from these actions.

3.2.1 Car policy actions

Many companies offer company cars to their employees, whether it is as a form of salary, or as a requirement to fulfil the job (e.g. sales representatives). In these last years, a tendency towards ‘greening’ the company car fleet can be seen. Companies see it as their responsibility to lower the impact of their activities, including the vehicle fleet, and at the same time cut costs. One way of doing so, is by changing the car policy and thus restricting the possibilities for employees when choosing a new company car.

Results

Among our FLEAT pilot actions, we had 4 company car fleets were the car policy was changed. In total, 428 new vehicles were purchased within the new car policies. These vehicles have a yearly average drive distance of more than 31.000 km per vehicle. The newly purchased vehicles have a 10,5 % lower fuel consumption than the other, 'older' vehicles in the fleet. In this way a total of nearly 290 tons of CO_2 were saved over a period of one year.

FLEAT partner	Pilot action	Fuel reduction %	Fuel reduction (l/100km)	Number of vehicles	Km / year	Original fuel consumption (l/100km)
VITO	KBC	-14,0	1,0	28	35718	6,8
VITO	Athlon Car Lease	-16,4	1,1	21	30633	7,0
BAUM	DATEV	-9,6	0,8	349	30970	7,9
BAUM	Weleda	-14,3	1,0	30	32440	7,0

FLEAT partner	Pilot action	Amount of fuel saved (liter)	Kg of CO_2 saved/year	Total number of vehicles	Potential savings (kg CO_2/year)
VITO	KBC	9601	25347	975	882606
VITO	Athlon Car Lease	7334	19361	70	64535
BAUM	DATEV	82145	216862	631	392092
BAUM	Weleda	9732	25693	105	89925
		total	287262	total	1429158

Potential

If all company cars in the 4 fleets were to be replaced by cars that comply with the new car policy, in total more than 1.400 tons of CO_2 could be saved on a yearly basis.

Cost effectiveness

A change in car policy does not require additional costs. Instead, in some company schemes a trade-off is made, where employees might choose a smaller car or smaller engine but with a higher level of comfort. For some employees, having to choose a less performing engine is seen as a drawback. The objectives of the fleet manager might therefore be in contradiction to the objectives of the HR department.

Taking only the investment cost into account, the cost per CO2 is zero, thus the payback period is zero as well. The cost per CO2 saved is also calculated taking into account the savings over a period of 5 years due to lower fuel consumption. The last result is displayed as "cost per ton CO_2 saved (overall cost)".

	€0/driver
Average fuel cons	7,7 l/100km
Average yearly distance	31.367 km
Total yearly fuel cons	2.415 l
Fuel reduction through car policy	10,5%
Yearly savings (à 1,2 € per liter of fuel)	ca. €300
Payback period	0 years
Cost per ton CO_2 saved (investment cost only)	€0/ton CO_2
Cost per ton CO_2 saved (overall cost)	€ -455/ton CO_2

3.2.2 Actions with CNG light duty vehicles

There were 2 FLEAT pilot actions where conventional vans were replaced by CNG-vans. Both fleets (DHL Express, Belgium, and Hamburg Wasser, Germany) used the same type of CNG vehicle. The advantage of CNG light duty vehicles lies in the fact that the level of direct pollutant and CO_2-emissions is significantly lower than with petrol and diesel vehicles. When comparing the environmental impact of 2 fuels, one should in fact calculate in terms of well-to-wheel emissions. If the well-to-wheel emissions are compared, the advantage of CNG is even greater since no energy intensive refinery process is needed.

Results

The 2 fleets consisted of 65 CNG-vehicles in total. The vehicles of the DHL fleet showed a 12,4% lower direct CO_2-emission than the diesel vehicles they replaced (210,3 compared to 240,1 g/km). For the Hamburg Wasser fleet, this difference is 18,9% (149,9 compared to 184,7 g/km). When the well-to-wheel phase is taken into account, the reduction is even greater: between 21,1 and 26,9% less CO_2 is emitted. This means that the vehicles in the FLEAT pilot actions saved up to nearly 30 tons of CO_2 directly, and more than 50 tons on a well-to-wheel basis.

FLEAT partner	Pilot action	Fuel	Fuel consumption		Direct CO2 emission per vehicle (g/km)	Number of vehicles	Yearly mileage per vehicle (km)
VITO	DHL Express	CNG	8,3	kg/100km	210,3	5	21630
		Diesel	9,1	l/100km	240,1		
BAUM	Hamburg Wasser	CNG	5,9	kg/100km	149,9	60	12515
		Diesel	7,0	l/100km	184,7		

FLEAT partner	Pilot action	Fuel	Pilot fleet direct CO2-emission kg/year	Kg of CO2 saved/year (direct)	well-to-wheel CO2-emission kg/year	Kg of CO2 saved/year (well-to-wheel)	reduction WTW %
VITO	DHL Express	CNG	22718	3264	24554	6556	21,1
		Diesel	25982		31109		
BAUM	Hamburg Wasser	CNG	112395	26371	121478	44673	26,9
		Diesel	138766		166152		
			total	29635	total	51229	

FLEAT partner	Pilot action	Fuel	Total number of vehicles in fleet	Potential direct savings (kg CO2/year)	Potential well-to-wheel savings (kg CO2/year)
VITO	DHL Express	CNG	5	3264	6556
		Diesel			
BAUM	Hamburg Wasser	CNG	800	351615	595645
		Diesel			
			total	354879	602201

Potential if pilot action is scaled up to the entire company fleet.

Potential

The DHL Express fleet only substituted the small vans that are used for urban distribution in the city of Antwerp by CNG-vans. The small vans that are not used for city distribution are not suited to be replaced, since there would be refuelling problems. There are only 3 CNG-refuelling stations in the whole of Belgium, one of which in Antwerp. The potential is therefore not very great for the small vans in the fleet of DHL Express. However, DHL Express decided to replace also the larger vans that are used for city distribution in Antwerp by CNG-vehicles.
The Hamburg Wasser has in total 800 small vans in their fleet. If they would all be replaced by CNG-vans, more than 350 tons of CO_2 would be saved directly, and more than 590 tons of CO_2 on a well-to-wheel basis.

Cost effectiveness

Both pilot actions used the Opel Combo as the CNG vehicle. If we take this particular car as an example, the difference in price between the diesel (1.7 CDTI 73 kW) and the CNG version (1.6 CNG 69 kW) is approximately € 1200 (reference www.opel.be). Based on the results of the FLEAT pilot actions, the yearly savings amount up to € 564, leading to a payback time of 2,1 years.

The cost per ton CO_2 saved is first calculated as the initial cost divided by the amount of CO_2 saved over a period of 5 years. Second, the cost is also calculated taking into account the savings over a period of 5 years due to lower fuel consumption. The last result is displayed as "cost per ton CO_2 saved (overall cost)".

	€ 1200/vehicle
Average fuel cons diesel	7,2 l/100km
Average fuel consumption CNG	6,1 kg/100km
Average yearly distance	13216 km
Total yearly fuel cons diesel	952 L
Total yearly fuel cons CNG	806 kg
Total yearly cost diesel (à 1,2 € per liter)	€ 1142
Total yearly cost CNG (à 0,7 € per kg)	€ 564
Payback period	2,1 years
Cost per ton CO_2 saved (WTW, investment cost only)	€ 304 /ton CO_2
Cost per ton CO_2 saved (WTW, overall cost)	€ -422 /ton CO_2

3.2.3 Actions with CNG heavy duty vehicles

There was one FLEAT pilot action where 8 CNG-busses were tested (AVM, Italy). As stated above (see 3.2.2), it is important to compare 2 fuels in terms of well-to-wheel emissions, and not only in terms of direct or tailpipe emissions.

Results

The CNG busses were compared to a conventional diesel bus. The average fuel consumption of this conventional bus is known from other, similar routes. Therefore, the presumed total fuel consumption can be calculated/estimated.

The direct CO_2-emissions of the diesel bus would have been lower than the CNG-bus on the same trajectory and with the same yearly driven distance. The diesel busses would have emitted 239 tons of CO_2, where the CNG-busses emitted 256 tons of CO_2. When comparing well-to-wheel data, the CNG-busses emitted less CO_2: 276 tons compared to 286 tons for the diesel busses. Since these busses were driving in an urban area, maybe the highest environmental gain lies in the fact that CNG-busses have much lower levels of pollutant emissions (especially PM and NOx), since these busses already comply with euro 6 emission standards.

FLEAT partner	Pilot action	Fuel	Fuel cons.		direct CO2 emission		Number of vehicles	Yearly mileage
TRT	AVM	CNG	37,0	kg/100km	939,8	g/km	8	34036
		Diesel	33,2	l/100km	875,9	g/km		

FLEAT partner	Pilot action	direct CO2-emission kg/year	Kg of CO2 saved/year (direct)	well-to-wheel CO2-emission kg/year	Kg of CO2 saved/ year (WTW)	Total number of vehicles	Potential direct savings (kg CO2/year)	Potential WTW savings (kg CO2/year)
TRT	AVM	255590	-17000	276245	9431	350	-743735	412589,7
		238590		285676				

Potential

The AVM has in total 350 busses in their fleet. If they would all be replaced by CNG-busses, direct CO_2 emissions would increase with more than 740 tons, but on a well-to-wheel basis there would be a decrease of more than 410 tons of CO_2.

Cost effectiveness

Based on the bus price list published every month by the magazine “Autobus”, and on various official tenders issued by PT operators, the cost for both types of buses is estimated at:

- M 231 C CNG Vivacity 9,7 m: € 225.000 + VAT
- M 231 C Diesel Vivacity 9,7 m: € 195.000 + VAT

The difference in purchase cost of € 30.000 is countered by the lower fuel costs during operation (yearly difference of € 4.745). For this particular case, the payback period would be 6,3 years.
Taking into account the CO2 savings on a well-to-wheel basis, the cost per ton CO2 saved is calculated to be € 4.945 taking into account only the investment cost. It the fuel savings over a period of 5 years are also taken into account, the cost per ton CO2 saved is lowered to € 1.035. It is important to mention that these numbers or based on a data from only one vehicle.

	€ 30.000/vehicle
Average fuel cons diesel	33,2 l/100km
Average fuel consumption CNG	37,0 kg/100km
Average yearly distance	34036 km
Total yearly fuel cons diesel	11300 L

Total yearly fuel cons CNG	12593 kg
Total yearly cost diesel (à 1,2 € per liter)	€ 13560
Total yearly cost CNG (à 0,7 € per kg)	€ 8815
Payback period	6,3 years
Cost per ton CO_2 saved (WTW, investment cost only)	€ 4.945 /ton CO_2
Cost per ton CO_2 saved (WTW, overall cost)	€ 1.035 /ton CO_2

3.2.4 Other actions on clean vehicles

Electric vehicles

One FLEAT pilot action included the use of electric vehicles. Voralberger Elektroautomobil Planungs- und Beratungs GmbH (VEA) has included 13 electric vehicles in their fleet of approximately 100 vehicles in total. The electric vehicles "Think City" were monitored during 7 months in 2009, with a total distance covered of 33335 km.

In this pilot, total energy consumption of the vehicles is compared to the official energy consumption. It should be noted that the official consumption does not include energy losses such as heating, standby and charging losses. These losses are included however in the monitoring of the vehicles during the FLEAT pilot action.

The CO2 emissions that are the consequence of electricity generation are different from country to country, depending on the technology used. For Austria, we use the figure of 0,221 kg CO2/kWh which allows us to calculate average CO2 well-to-wheel emissions (g/km) for these electric vehicles.
(source: http://manyeyes.alphaworks.ibm.com/manyeyes/datasets/co2-emission-per-kwh-kg-co2-kwhel-fo/versions/1)

FLEAT partner	Pilot action	Average energy consumption (kWh/100km)	Official energy consumption (kWh/100km)	Average CO2 emissions WTW (g/km)	Total Distance (km)	Total energy consumption (kWh)
AEA	VEA	35,9	18	79,2	33335	11951,1

The results of the pilot action show an average energy consumption of 35,9 kWh/100km during real-life circumstances, which is almost double of the official energy consumption. As stated above, the between the two is partly due to the extra losses that are not taken into account in the official energy consumption. Using the figure of 0,221 CO2/kWh for Austrian electricity generation, the WTW CO2 emissions amount up to 79,2 g/km. A comparable diesel city car like the smart fortwo cdi has a CO2 well-to-wheel emission of approximately 103 g/km. On a yearly basis, about 1371 kg CO2 would be avoided by choosing an electric car over a similar small diesel car in this pilot fleet.

This pilot case clearly marks the importance of electricity generation when moving to electric vehicles or PHEV's (plug-in hybrid electric vehicles). In case CO2 emissions related to electricity generation are high due to e.g. the use of coal, the advantage to traditional ICE (internal combustion engines) will fade. On the other hand, the use renewable energy for electric vehicle propulsion will greatly enhance their well-to-wheel impact compared to ICE.

Hybrid Vehicles

One FLEAT pilot action included the monitoring of the fuel consumption of hybrid vehicles in daily operation. The ÖBB Holding AG operates a fleet of approximately 4000 vehicles. In this pilot case, two hybrid vehicles were monitored for their fuel consumption

- Honda Insight hybrid
- Toyota Prius hybrid

Fuel consumption results are shown in the table below. Due to the limited number of cars and the limited distance driven, especially in the case of the Toyota Prius, no further conclusions will be drawn for this pilot.

Vehicle Model	Distance driven (km)	Average fuel consumption (l/100km)	Average direct CO2 emission (g/km)	Average WTW CO2 emission (g/km)
Honda Insight Hybrid	10566	6,08	145	170
Toyota Prius Hybrid 1,5	1082	5,15	123	144

Postbus Lightweight Bus

The Austrian public transport company Postbus GmbH operates a fleet of 2100 buses. In this FLEAT pilot action, the fuel consumption of a lightweight bus was compared to a traditional bus. The lightweight prototype bus is a converted "MAN DGL" bus, built by the Austrian bus manufacturer Kutsenits. The effects on fuel consumption were tested through the daily monitoring of fuel consumption and a parallel comparison with the energy demand of a conventional bus ("MAN R12 Lion Regio") on the same route. The results on the fuel consumption are given in the table below.

	Distance (km)	Total fuel consumption (liter)	Average fuel consumption (l/100km)	Average direct CO2-emission (g/km)	Yearly total direct CO2-emission (kg/year)	Yearly total WTW CO2-emission (kg/year)
Lightweight bus	5032	1384	27,5	904	57973	69414

Reference bus	5636	1930	34,24	726	80861	96819
Difference			6,74	178	22888	27405

For the 1 bus tested in this pilot case, yearly savings in direct CO2 emissions amount up to 22.9 tons, whereas the WTW savings are estimated at 27,4 tons per year. No further information on cost is available, therefore no conclusions on cost/benefit will be drawn.

Holcim Eco chiptuning

Holcim is one of the world's leading producers of cement and aggregates – both key basic materials for construction. The Group also supplies ready-mix concrete and asphalt, and offers a range of other services. The Holcim fleet consists of 270 heavy dsuty vehicles. For this FLEAT pilot action, 33 vehicles were tested with and without "eco" chip tuning (adaptation of parameters in the electronic engine controller).

The test results indicate a reduction in average fuel consumption of 1,5 l/100km (-4%), leading to a return of investment of 1,5 years.

Number of heavy duty vehicles	Fuel consumption average l/100km	Fuel consumption Spread between lowest & highest vehicle	CO2-Emission g/km	CO2-Emission total by 33 vehicles (=2,3 Mio Km) In kg
33 before eco chip tuning	36,01	31,71-40,64	954	2194200
33 with eco chip tuning	34,55	29,64-40,15	916	2106800
Reduction via pilot action	-1,46		-38	87400

SAB-tours Optimization of fuel injection

SAB Tours is private bus company with a fleet of 130 buses. Three buses were equipped with a GGMS, a system to optimize fuel injection. The vehicles were tested for approximately 3 months with the device installed. The vendor of the system promised a fuel reduction of 5-10%. In this pilot case, this fuel reduction was not achieved. Results are shown in the tables below. The difference on the first two buses is too small to be of importance, and on the third bus even an increase in fuel consumption was seen. No further conclusions are drawn for this pilot.

Bus ID	With/without GGMS device	Fuel consumption (l/100km)	Distance driven (km)
74201 Solaris 1	without	32,3	19.57
74202 Solaris 2	with	32,1	18.344
Difference		-0,2	

Bus ID	With/without GGMS device	Fuel consumption (l/100km)	Distance driven (km)
72701 Sprinter 1	without	18,4	16.432
72702 Sprinter 2	with	18,3	16.307
Difference		-0,1	

Bus ID	With/without GGMS device	Fuel consumption (l/100km)	Distance driven (km)
75805 Bova	without	28,3	38.433
75805 Bova	with	29,9	34.939
Difference		+1,6	

3.3 Results pilot actions on mobility management

The FLEAT pilot actions on mobility management included different types of measures. The effect of these measures was hard to assess, and the fact that they were all different made it very difficult to compare them to one another. Therefore, the pilot actions on mobility management will be discussed individually.

3.3.1 Hamburg Wasser – carpool system

Description

Unlike traditional carpool-schemes, the Hamburg Wasser company piloted two different booking systems for shared cars. The objective was to check whether usage would increase by using an automated system instead of using a telephone agency. The pilot action ran from January 2009 until August 2009 in three different branches of the company. In one branch the automated system (based on Lotus Notes) was tested, in two other branches they kept on using the telephone agency. In total 40 utility vehicles and 100 drivers were involved.

Results

The degree of capacity utilisation is slightly higher in case of Lotus notes, but the advantage of the personal booking system via telephone agency is to exhaust the potential of synergies (to combine two reservations) and to avoid surplus preventive and fulltime bookings. The degree of capacity via lotus notes is 5% higher than by telephone agency, but we have 8% incidents of surplus booking.

Car pool	Booking-system	number of vehicles	capacity (days)	actually used (days)	degree of capacity utilisation (%)	booked (days)	surplus booked (%)
Billhorner Deich	lotus notes	17	2839	2420	85%	2613	8%
Bankstrasse	telephone agency	14	2048	1650	81%	Not assessed	Not assessed
Pinkertweg	telephone agency	9	1503	1189	79%	Not assessed	Not assessed

Conclusion

In terms of optimisation of capacity usage the conclusion is not clear. Although the automated system generates a positive effect on the usage, double bookings are higher than with the telephone agency. This could be explained by system failure and can be remedied quite easily in the future.
In terms of CO2-reduction the effects are too small and undefined to give any trustworthy conclusion, according to the company-owner.

3.3.2 Postbus – stop on demand

Description

The Postbus is a well known sight in Austria. As most other bus lines, the Postbus has predefined routes and stops which are set out to reach as much passengers as possible. This means that they often have to go off the main and most efficient route to pick up passengers in neighbouring villages. The problem is that the bus drivers don't know beforehand whether there will be passengers waiting or not and thus the bus sometimes makes unnecessary detours. To tackle this problem the Postbus GmbH equipped 17 out of 52 bus stops with a bus on demand system. This system enables passengers to notify bus drivers in advance. The pilot action ran from December 2009 until March 2010 and consisted of 1 pilot vehicle and 1 reference vehicle. The Postbus GmbH has a total of 2100 vehicles in service. This shows a high potential for up scaling the effects of the pilot action.

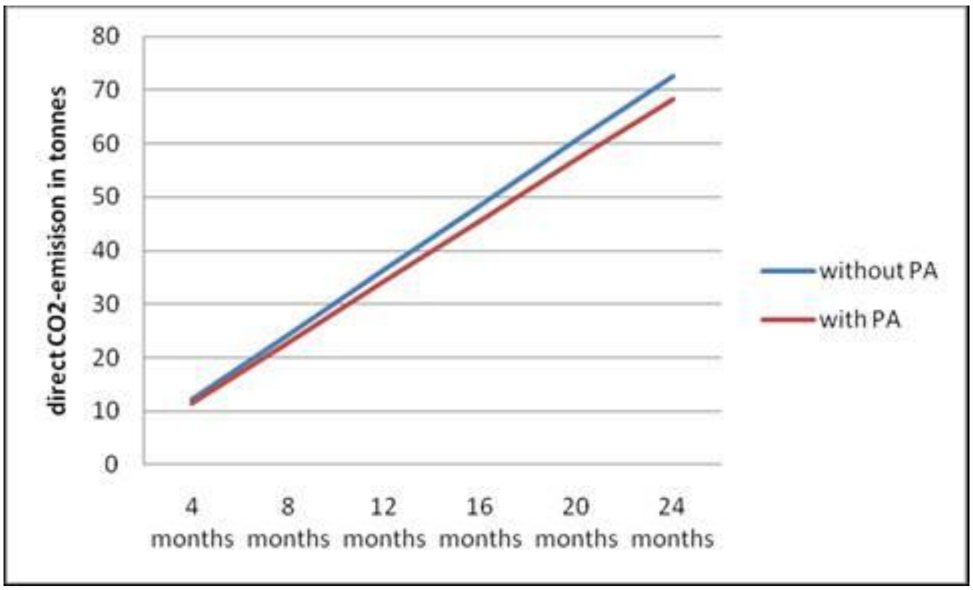
Results

The results show a clear decrease in distance driven and accordingly also a decrease in fuel consumption and direct CO_2-emission. The total CO_2-reduction is 700 kg in only 4 months time.

	Distance driven (km)	Total fuel consumption (l)	Average fuel consumption (l)	Direct CO2-emission (tonnes)
With PA	14432	4328.56	29.99	11.4
Without PA	14560	4600.96	31.66	12.1

Conclusion

The action shows a clear positive effect on CO_2-emissions. With a sustained effort over a period of 2 years time, one bus with 17 equipped stops can gain a reduction of 4.2 tonnes CO_2. If all buses would be equipped with the system, the gain could hypothetically be 4410 tonnes less CO_2 per year.



3.3.3 ISIS – route optimisation

Description

ISIS is a food distribution company in Craiova, Romania. Therefore, they have a fleet of 18 vans and 2 passenger cars in service on a daily basis. To cut fuel costs the company was looking into different ways of route optimisation. IPA of the FLEAT-consortium provided a system and assisted in the implementation. The pilot action ran from September 2008 until December 2009 and involved all vehicles in the fleet.

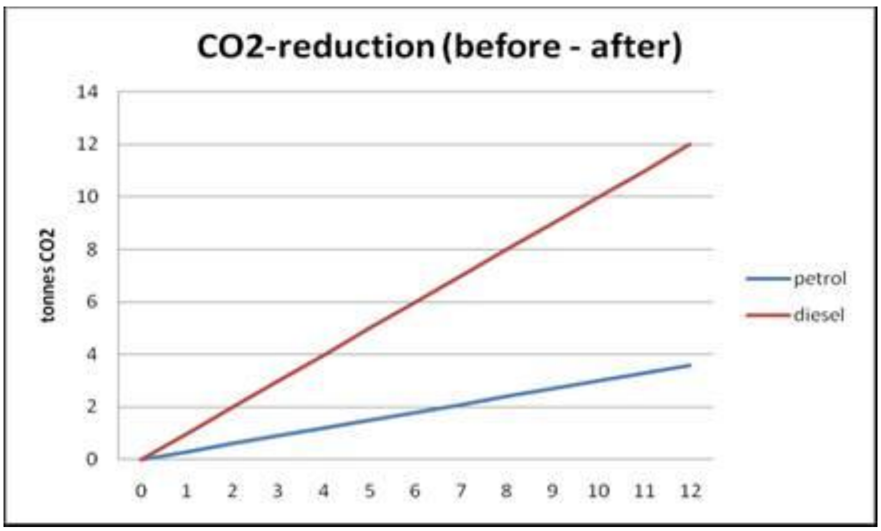
Results

However there's a slight increase in distance driven, due to efficient route planning resulting in optimal routing without unnecessary stops a decrease in fuel consumption could be obtained.

	Petrol vehicles		Diesel vehicles	
	before	after	before	after
Distance driven (average per month)	9569,6	9655,167	27758,9	27880,67
Fuel consumption (average per month)	801,747	683,1133	2577,906	2183,088

Conclusion

Route optimisation has got a clear effect on fuel consumption. Due to efficient planning of routes the company can cut costs, can lessen the environmental impact of its activities but also gains on the profit side (more km's driven thus more distribution). The gains in CO2-reduction are quite easy to describe: the petrol cars reduced 300 kg of CO2 after one month, the diesel cars reduced 1 ton of CO2 after 1 month.



3.3.4 Stadtwerke Gleisdorf – garbage collection

Description

The public body of Stadtwerke Gleisforf wanted to optimize its garbage collection by using a system called 'Intelligent waste container'. The clue of the system is to avoid redundant trips by having a tell-tale system in place which enables users to notify the designated service when the garbage should be collected. The pilot action ran from May 2009 until September 2009 and involved 2 large trucks, one with the system and one without. Stadtwerke Gleisdorf has a total of 35 vehicles in service.

Results

The results show a steep drop in distance driven and accordingly in fuel consumption and direct CO2-consumption. Apparently, there were quite a few redundant trips which could be avoided by the tell-tale system.

	Distance driven (km)	Total fuel consumption (l)	Direct CO2-emission (ton)
With PA	444	222,715	0.6
Without PA	1595	797,55	2.1

Conclusions

The drop in CO2-emissions is quite spectacular, even for only one vehicle. If all 35 vehicles would be equipped with the system, 52.5 tonnes of CO2-emissions could be avoided.

3.3.5 City of Turnhout – carpool

Description

The city of Turnhout owns 7 company cars for business trip purposes. By using a shared car, they can reduce CO2-emissions and costs. Next to that the city wants to adopt a green mobility policy, including company bikes, reduction of trips, green procurement and carsharing. To operationalise the pilot action a comparative test was done between 1 company car (Renault Modus) and 1 shared car (VW Polo, provided by Cambio), during 1 month.

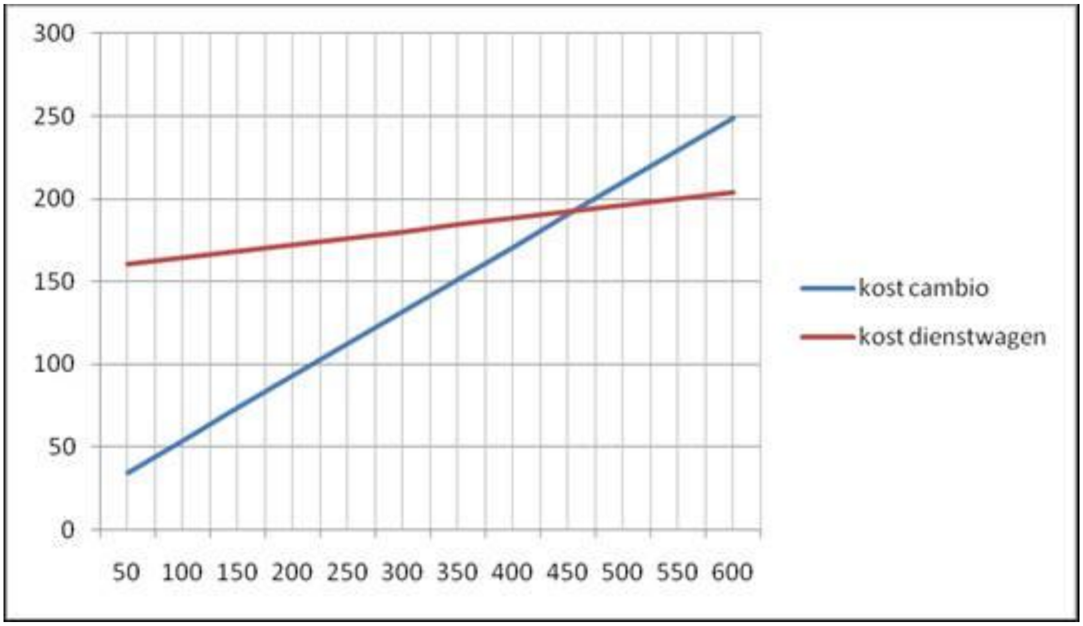
Results

After the pilot action the results were the following: a reduction of cost of 65.32 euro and a reduction in CO2 of 525 g, although the shared car had more mileage (+36 km's). If these monthly results are representative for the 11 other months this can be scaled up to 783.84 euro cost reduction and 6900 g of CO2-reduction.

	Distance driven (km)	Total fuel consumption (l)	Direct CO2-emission (g)
Company lease car	161	9,66	23345
Shared car	230	8,74	22770

Conclusion

By using a shared car, the city of Turnhout reduced CO2-emissions, but also cut costs. Extrapolated over a period of one year of combined use the city can reduce 6900 g of CO2. However, there's also a factor which must be taken into account. When comparing the cost structure of the use of both the company car (lease contract) and the shared car (private carsharing service Cambio) we saw a big difference in variable and fixed cost. For the lease-car the fixed cost per month is quite high, but the usage cost is low. For the shared car, this is the other way around. When set out in a graph consisting of costs per kilometer, we see there's a turnover point at approx. 450 km's. This means that the shared car starts to cost more than the company car once the mileage goes above 450 km's. Of course, the environmental benefits continue to be greater with the shared car. Of course, this example can't be generalised, as it's based on the specific cost structure in this case and the technical specs of the cars involved in the pilot action, but it gave a clear view on how to proceed on comparing car usage on costs and environmental issues for the pilot partner.



3.3.6 Feistritzwerke – route optimisation

Feistritzwerke STEWEAG GmbH is an Austrian regional utility based in Gleisdorf, Styria and supplies approx. 30.000 customers with electricity.

In this FLEAT pilot action, the company employed a GIS and GPS supported route optimisation programme to reduce the number of trips and the average number of kilometres driven by company vehicles used for maintenance and repair work. The software which was used has been tailor-made according to the requirements and needs of Feistritzwerke STEWEAG GmbH.

A total of 45 vehicles (a mix of passenger cars and small vans) were part of the FLEAT pilot action on route optimalisation. All 45 vehicles were monitored for exactly 1 year before, and 1 year after the mobility management measures were put in place. The results on the total distance driven are shown in the table below.

	Total distance (km)	Total fuel used (liter)	Average fuel consumption (l/100km)
Before	582.364	62.878	10,77
After	518.411	53.682	10,55
difference	-63.953	-9.196	-0,2

The total distance driven by the vehicles for maintenance and repair work decreased by 11,0 % or almost 64,000 km after the introduction of the route optimisation programme. This leads to a yearly saving in CO_2 emissions of approximately 29 tons/year (WTW).

3.3.7 Conclusion on pilot actions on mobility management

It is clear that mobility management measures can gain some positive effects on CO2-emissions with public and private fleets. Especially those schemes where an intelligent system of avoiding trips or more efficient routing is used, gain the best effects in terms of CO2-reduction. More precisely, with the pilot actions in mobility management FLEAT saved 3.5 tonnes of CO2. Extrapolated over one year of sustained effort and follow-up, that number increases to 22.1 tonnes CO2. Furthermore, most pilot actions indicate that expansion of the pilot action is possible and feasible (more trucks and buses equipped with a system, more stops). This will increase the positive effect on CO2-emissions even more, strengthened by the idea that all pilot actions are highly transferable to other fleets which may want to benefit from the lessons learnt in FLEAT.
It's important to mention that not only CO2-reduction is accomplished but that also a significant cost reduction is shown in the pilot actions. This seems to be an important driver or motivator for companies to implement mobility management measures.

3.4 Results on pilot actions

From our experience, the easiest way to reduce CO2 emissions of passenger car fleets is to adapt the car policy. The newly purchased vehicles in the FLEAT pilot actions had a 10,5 % lower fuel consumption than the other, 'older' vehicles in the fleet. This type of action does not require any additional costs for implementation, while the lower fuel consumption immediately leads to CO_2 savings and lower operating costs. The FLEAT pilot actions on car policy led to a direct CO_2 saving of 287 tons (for a period of 1 year), with a potential saving of 1429 ton if the pilot action would be extended to the total fleets.

When looking at costs, the next best option is to implement ecodriving schemes for all drivers in a fleet. Based on our FLEAT pilot actions, we estimate the costs of this type of measure to be between € 300 and € 1.000 per driver. This is including the trainer and loss of man hours, and is independent from the type of vehicle. Because of the higher yearly mileage and the higher fuel consumption, the possible profits are higher for busses and trucks than for passenger cars and small vans. In addition, the largest effect in terms of relative reduction was seen with trucks (-9,4%), followed by busses (-7,2%) and then light duty vehicles (-6,4%). From these numbers we can conclude that the payback period is shortest for trucks (1,3 to 4,3 months), and longest for light duty vehicles (1,6 to 5,2 years). The amount of CO2 saved in the FLEAT pilot actions on ecodriving amount up to 274 tons for passenger cars, 1680 tons for buses, and 1923 tons for trucks.

For light duty vehicles, switching from diesel to CNG (compressed natural gas) powered cars proved to be a viable option. The advantage of CNG light duty vehicles lies in the fact that the level of direct pollutant and CO_2-emissions is significantly lower than with petrol and diesel vehicles. If the well-to-wheel emissions are compared, the advantage of CNG is even greater since no energy intensive refinery process is needed. Results from 2 FLEAT pilot cases indicate well-to-wheel CO2 savings of 21 to 27%. The extra cost for a CNG vehicle when compared to the diesel version is approximately € 1200 for the type of cars used in these pilots. On the other hand, the fuel cost per kilometre driven is substantially lower for CNG than for diesel vehicles. Based on the numbers of the FLEAT pilot actions, the yearly savings in fuel costs amount up to € 564, leading to a payback time of 2,1 years. A total of 65 light duty vehicles running on CNG took part in the FLEAT project, leading to a savings of 51 tons of CO_2 over a period of 1 year.

Switching from diesel to CNG for heavy duty vehicles requires a longer payback time of 6,3 years. It should be noted that this number is based on the results of only one pilot case , including 8 CNG-busses. Therefore, the results should be seen as indicative. The direct CO_2-emissions of the diesel bus were lower than the CNG-bus on the same trajectory and with the same yearly driven distance. However, when comparing the well-to-wheel data, the CNG-buses emitted less CO_2 (-3.4%). Over a period of 1 year, a total of 9 tons of CO_2 was saved in the FLEAT action using these CNG-buses instead of diesel ones. Since these buses were driving in an urban area, maybe the highest environmental gain lies in the fact that CNG-busses have much lower levels of pollutant emissions (especially PM and NOx), since these busses already comply with euro 6 emission standards. The difference in purchase cost of € 30.000 is countered by the lower fuel costs during operation (yearly difference of € 4.745). For this particular case, the payback period would be 6,3 years.

Other FLEAT pilots on clean vehicle technology included energy consumption monitoring for electric vehicles (35,9 kWh/100km, leading to 79,2 g/km CO2 emission), fuel consumption monitoring for hybrid electric vehicles (123-145 g/km CO2 emissions), lightweight buses (savings of 178 g/km CO2 emissions), eco-chiptuning (savings of 38 g/km CO2 for heavy duty vehicles), and systems for optimization of fuel injection (no difference). Approximately 28 tons of CO_2 were saved using these technologies in the FLEAT pilot actions. Because of the limited number of vehicles involved, no further conclusions are given on these results.

The last type of pilot cases included actions on mobility management. These actions included different types of measures. The effect of these measures was hard to assess, and the fact that they were all different made it very difficult to compare them to one another. Pilot cases included new carpool systems, stop-on-demand for public transport buses, route optimisation for logistic operations, intelligent garbage collection and car-sharing for company cars. From the pilot case results, it is clear that mobility management measures can gain some positive effects on CO2-emissions with public and private fleets. Especially in those schemes where an intelligent system of avoiding trips or more efficient routing was used, impressive fuel savings could be made. Direct CO2 savings in the FLEAT pilot actions on mobility management amount up to 50 tons for the duration of the actions. It’s important to mention that not only CO2-reduction is accomplished but that also a significant cost reduction is shown in the pilot actions. This seems to be an important driver or motivator for companies to implement mobility management measures.