Sustainable Mobility

CO_2 in the Road Transport Sector

The Integrated Approach
A study by OICA

International Organization of Motor Vehicle Manufacturers OICA

Foreword by OICA President Dave McCurdy

The auto industry is on the leading edge of the world's efforts to reduce Carbon Dioxide (CO_2) emissions. In fact, the industry often outperforms other sectors of the world's economy, and globally we continue to do more even during these challenging economic times.

As the International Organization of Motor Vehicle Manufacturers (OICA), we recognize that we are an important part of the solution and join the world's communities to work toward our shared environmental goals. However, true success requires an intelligent, coherent and pragmatic integrated approach; one that includes multiple stakeholders and methods. New technology, like the vehicle technologies the auto industry brings to the world's consumers, can only be part of the answer.

We must acknowledge that different cultures and markets have diverse characteristics, and drivers behave and use their vehicles differently depending on where they live. Just buying, selling or owning a fuel-efficient vehicle is not enough. Policymakers must look at the quality of fuels our vehicles run on, how to get those fuels to consumers affordably, the condition of our roads, the way we manage our traffic patterns, and of course, how we engage consumers and drivers. To reach our common goal we all must be part of a collaborative, constructive dialogue that shares our knowledge and best practices among government, automakers, and other key stakeholders.

OICA's 2008 report on the global industry's impact on CO_2 showed that road transport emissions comprised 16% of manmade CO_2. We are actively working to reduce that amount further, but we understand that we cannot do it alone; broad measures involving other stakeholders can magnify the transport sectors' CO_2 reductions.

Today's study, Sustainable Mobility, CO_2 in the Road Transport Sector, The Integrated Approach: a study by OICA, analyzes concrete measures established around the world that maximize our industry's achievements. Renewing vehicle fleets, managing congestion and influencing driver behaviors are just some of the initiatives that can address issues beyond the auto industry's reach.

OICA believes that the global auto industry is an important part of the solution. However, as this study demonstrates, we can all move forward more efficiently when we have other stakeholders joining us. We look forward to partnerships and collaboration with policymakers, energy providers, consumers and others to share best practices that will reduce the transport sector's carbon footprint, while still preserving the benefits of sustainable mobility.

1. INTRODUCTION

In 2008, OICA, the International Organization for Motor Vehicle Manufacturers, published a paper on the issue of road transport and CO_2 emissions.

One of the key findings is the fact that road transport, according to official sources, accounts for about 16% of the global man-made CO_2 emissions. This percentage clearly shows that road transport cannot solve the whole CO_2 issue on its own; at the same time, it also shows that road transport has a role to play.

Any policy decision, however, needs to be based on facts and figures in order to reach maximum efficiency. In particular, one must remember that transportation in general is a key element of economic and social welfare, in which road transport plays a very important role. The auto industry provides the tools to fulfil road transport demand; producing and maintaining these tools also provides employment to tens of millions of people all over the world.

Automobile manufacturers are continuing to invest billions in research and development, including the development of less CO_2 intensive transport systems in spite of the ongoing economic and financial crisis . There is an increasing number of low or even zero CO_2 emission vehicles currently on the road, or which are planned for introduction in the next 2 to 5 years. This means that vehicle manufacturers are taking their role in reducing CO_2 emissions seriously and there is no doubt that these efforts will continue. New alternative technologies can take multiple forms, from further improvements of internal combustion engines (gasoline, clean diesel, etc.), to hybridization, electrification, alternative fuels, and fuel cells. Some of the key concerns, however, include the fact that development of such radical new concepts requires lead-time. Bringing a new model to market can take 5-7 years, while a brand new technology takes even longer. Another concern is that the demand for mobility is and will remain strong, and that affordability must be maintained for the average consumer.

Therefore, OICA believes that while technology may offer part of the answer to the CO_2 emissions reduction issue, it cannot provide the whole answer. Technology requires lead-time for introduction, it needs to be affordable, and it needs to fulfil society's demand for mobility. OICA strongly promotes the concept of an "integrated approach", whereby all stakeholders are involved, from vehicle engineers to government authorities, as well as the vehicle users. Everyone has a role to play.

Starting from measures already put in place by countries around the world to reduce CO_2 emissions from road transport, this study aims to analyse those measures and solutions, which have shown concrete results, and to assess their effectiveness.

In particular, the measures shown in this study aim to encompass all factors responsible for CO_2 emissions reductions from road transport, and develop guidelines for such items as:

- **renewal of car fleet** (through special incentive programmes, CO_2 related taxation, etc);
- **traffic flow improvement** (through infrastructure improvements, intelligent transportation, road transport logistics, fiscal measures, car pooling/car sharing and mobility plans); and
- **eco-driving campaigns** influencing car-owners' driving behaviours.

These measures have been investigated in more detail throughout this study, gathering examples of policies applied in different countries, and reviewing the results obtained. The study is based on data and information collected by a questionnaire sent to OICA members, in addition to an in-depth literature review covering recent statistics, studies, notes etc., which analyse the different impacts and consequences of policies applied to address the CO_2 problem.

2. FLEET RENEWAL

It is indisputable that modern vehicles are more efficient than the vehicle generations they replace, not only in terms of safety or pollutant emissions, but also in terms of fuel efficiency.
In an effort to answer concerns regarding sustainable mobility, vehicle manufacturers are accelerating the development of new technologies, including low or even zero CO_2 emission vehicles, with massive research and development investments and deployment.

Internal combustion engines, using gasoline or diesel, have already undergone drastic changes over the past years, with amazing results in terms of fuel efficiency and driving comfort. As an illustration of these efforts, in 2009, automakers supported the US National Program to reduce CO_2 by 30% through 2016.

In the European Union, the constant decrease of the average CO_2 emission of new vehicles entering the market is shown in the following table:

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Average new passenger car CO_2 emissions in European Union (g/km)														
Portugal	171	169	165	163	159	156	157	152	148	145	144	144	143	138
France	176	175	175	171	166	162	156	155	155	153	152	149	149	140
Denmark	188	186	187	184	180	177	174	170	169	166	164	163	157	146
Italy	180	177	171	170	167	161	158	155	152	149	149	149	147	145
Belgium	182	180	177	174	170	165	161	159	157	155	154	153	153	149
Spain	176	175	172	171	167	162	159	156	153	150	150	156	157	152
Netherlands	188	186	185	181	177	174	173	172	173	170	169	165	164	157
United Kingdom	191	190	190	189	185	180	176	173	172	171	169	167	164	159
Austria	186	183	179	175	170	166	163	161	161	161	161	162	162	159
Ireland	179	178	174	176	171	167	168	167	166	168	167	166	165	159
Luxembourg	197	193	191	187	183	175	171	169	170	167	166	165	164	160
Finland	189						179	178	179	180	180	180	178	162
Greece	185	184	182	182	182	182	181	181	174	174	172	170	168	164
Germany	194	191	190	186	183	179	176	174	173	172	170	172	170	165
Sweden	221	216	210	204	201	198	199	199	200	198	194	188	182	175
EU average	**186**	**184**	**182**	**179**	**176**	**171**	**168**	**166**	**164**	**162**	**161**	**161**	**159**	**154**

Source : CCFA

The above data indicate that, on average, new vehicles in the EU have reduced their CO_2 emission levels by more than 17% in just 13 years. Similar data are found for Switzerland, where the average CO_2 emissions of new registered passenger cars improved almost 17% in 12 years[1].

1 Source : Auto-Schweiz / Auto-Suisse, 13e rapport dans le cadre de l'Ordonnance sur l'énergie – 2008

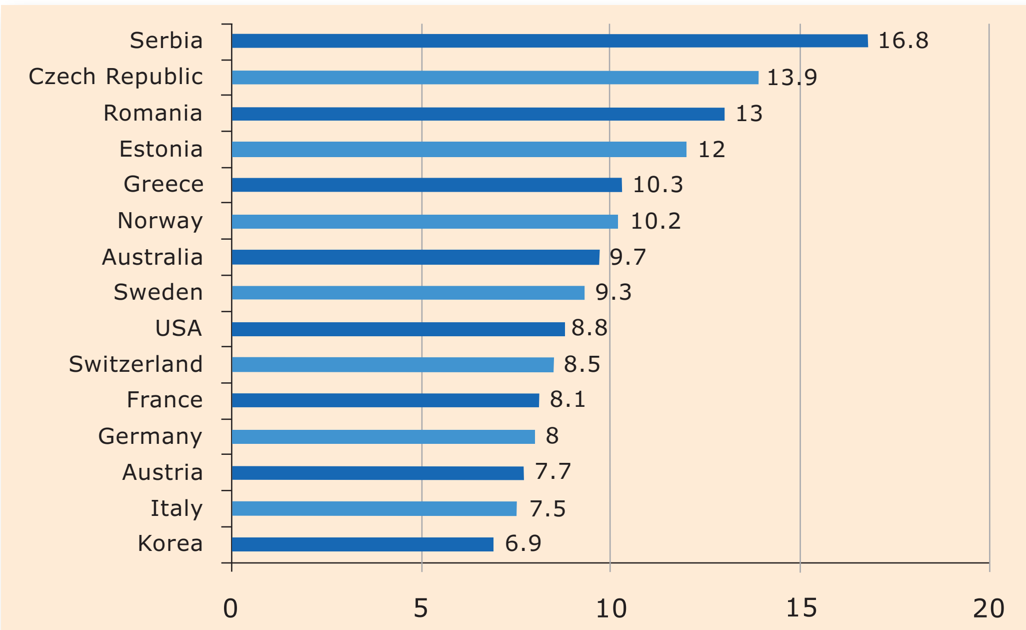
Further large scale improvements are continuing, with manufacturers aiming for further substantial improvements over the next few years, compared to current generation engines.

In addition, other new alternative technologies have already appeared on the market or are being developed, such as hybrids, electric cars, fuel cell cars, etc.

This means that as new vehicles gradually replace previous fleets, the quality and efficiency of road transport continues to improve in terms of road safety, as well as in terms of environmental protection. Such replacement however takes time and it is obvious that benefits may increase by speeding up this replacement process. In addition, care must be taken that new, improved vehicles remain affordable for consumers. Consumers not able to afford a new vehicle will obviously tend to keep their old car longer than they would otherwise have done, resulting in the postponement of technological improvements on the road. Such a phenomenon will likely be even more crucial in emerging economies, where the standard of living has not yet reached the levels of more developed economies.

This study compiled available experience in various countries in an effort to assess the realized CO_2 savings through fleet replacement or renewal. Scrapping schemes have been introduced in several countries, and looking at the average age of car fleets world-wide, there is considerable scope for this process to be further supported in order to direct customers' demand towards low emission vehicles.The table below shows the average age of the current passenger car fleet in several countries that are considered high to medium income levels. It is clear that even in such well developed economies, many cars currently on the road were developed more than 10 years ago and that there is scope for rejuvenation of the car fleet.
No data have been included for developing economies, but it is expected that figures in such countries would show an even larger potential for improvement.

2008 Passenger cars average age



Source: Compilation of individual national data
Note : Data of Australia, Greece, Italia, Serbia and Sweden refer to 2007

• Assessment of fleet renewal benefits

JAPAN: Since 2001, as the fleet was being renewed, road transport CO_2 emissions in transport sector progressively decreased (from 267 million tons in 2001 to 235 million tons in 2008, with a prediction of about 240 million tons for 2010)[2] mostly through increased vehicle fuel efficiency and improved traffic flow. This equals on average a CO_2 reduction of more than 4.6 million tons every year, and would be equivalent to the CO_2 emissions of more than 3.3 million vehicles every year (assuming vehicles emitting 140 g CO_2/km and driven 10 000 km annually).

ITALY: A study made by ANFIA shows the potential reduction of CO_2 emissions and yearly benefits due to the full replacement of Euro 0, Euro 1 and Euro 2 vehicles in Italy by newer technology models. **Total CO_2 saving** would amount to **8.74 million tons per year**[3]. This would be equivalent to the CO_2 emissions of more than 4 million cars every year !

Type of vehicles	CO_2 saving (tons/year)
Euro 0	- 2 350 000
Euro 1	- 1 790 000
Euro 2	- 4 600 000
Total	- 8 740 000

GERMANY: A study demonstrates that if the car fleet in Germany was one year younger on average, annual fuel consumption would be reduced by 800 million litres and road transport **CO_2 emissions would be reduced by 2 million tons**[4].

• Example of a fleet renewal measure: scrapping schemes

During the year 2009, several countries within and outside Europe implemented car scrapping schemes in an attempt to stimulate demand for motor vehicles in response to the financial and economic crisis. Although these programs cannot continue indefinitely, if only due to funding constraints, they demonstrate how effective fleet renewal can be at reducing CO_2 emissions through the deployment of new technologies.

Most of the data quoted in this study relate to European countries such as Germany, Italy, France, Austria, UK and Spain. The main findings (sources: National Associations of the Automotive Industries and ACEA) are as follows.

Sources :

2: Ministry of Environment, in "Reducing CO_2 Emissions in the Global Road Transport Sector"

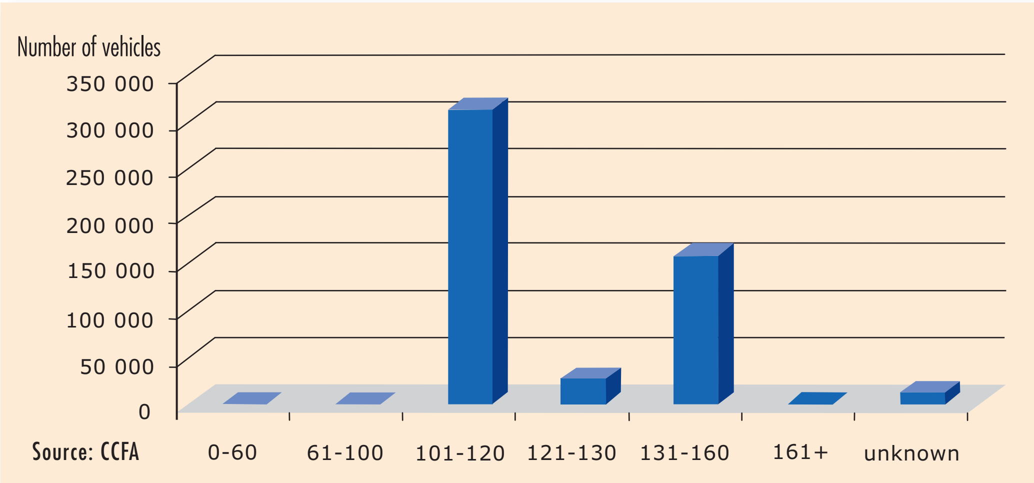
3: ANFIA

4: VDA

Country	Scheme characteristics	Duration	Average CO_2 emission reduction of newly registered cars
Germany	• incentive of 2 500€ • scrap vehicles 9 years old or more • purchase new car meeting at least Euro 4 emission standard, or used car maximum 1 year old	14-01-2009 31-12-2009	**- 11 g/km CO_2** (from 165 g/km to 155 g/km)
Italy	• scrapping incentive of 1 500€ to 5 000€ related to the age and the "Euro" emissions standard of the scrapped car and to the fuel consumption/CO_2 emissions characteristics of the purchased vehicle	07-02-2009 31-12-2009	**- 8.2 g/km CO_2** (from 144.8 g/km to 136.6 g/km)
France	• incentive of 1 000€ • scrap vehicles 10 years old or more • purchase new car emitting maximum 160 g/km of CO_2	04-12-2008 31-12-2009	**- 6 g/km CO_2** (from 140 g/km to 134 g/km)
Austria	• incentive of 1 500€ • scrap vehicles 13 years old or more • purchase new car meeting at least Euro 4 emission standard	04-2009 12-2009	**around 33 750 tons CO_2 saved**
UK	• incentive half paid by manufacturers	05-2009 02-2010	**- 20 g/km CO_2** (from 152 g/km to 132 g/km)
Spain	• incentive of 2 000€ • scrap vehicles 10 years old or more, • purchase new car emitting maximun 149 g/km of CO_2	05-2009 01-2010	**- 8.5 g/km CO_2**

Looking in more detail at the data for France, it is worth noting that a clear majority of the vehicles benefiting from these incentives schemes were very fuel efficient vehicles.

CO_2 emissions breakdown of new vehicles sold during the period of application of the French scrapping scheme



USA: The government-funded trade-in initiative called Car Allowance Rebate System of 2009 (CARS) helped put more fuel-efficient cars on the road. The program gave car buyers rebates of up to $4 500 if they traded in less fuel-efficient vehicles for new vehicles that met certain fuel economy requirements.

According to the National Highway Traffic Safety Administration's Report to Congress on the Consumer Assistance to Recycle and Save Act, December 2009, the new cars sold or leased under the CARS program had an average fuel consumption 34% lower than the vehicles they replaced.
The reduced fuel consumption over the next 25 years is estimated to be more than 3 billion litres, which equates to nearly 125 million litres of fuel annually. Total reduction in CO_2 emissions based on the estimated reduction in fuel consumption as a result of the CARS program is roughly 9 million metric tons of CO_2 and related GHGs over the next twenty-five years (see table below). This is equivalent to the annual greenhouse gas emissions from 1.8 million typical passenger vehicles during 1 year.

Estimated Reduction in Carbon Dioxide and GHG Emissions

	Total reduction in CO_2 emissions over 25 years	Average annual reduction in CO_2
CO_2 - Vehicle Use	7 994 437	319 778
CO_2 - Fuel Production and Distribution	1 018 457	40 738
Total	**9 012 894**	**350 516**

Source: NHTSA Calculation

• Influencing consumer behaviour

Around the world political, regional, and cultural differences make markets unique, and those differences must be considered when crafting successful CO_2-reduction policies. Despite the differing consumer habits and fleet composition from market to market, one principle that does appear versatile and widely effective in influencing consumer behaviour is the constructive use of tax policies. Price signals send consumers powerful messages.

CO_2-related taxation can have significant CO_2 emissions reduction potential by shaping consumer demand. Autos and fuels form a system, so tax policies that encourage consumers to purchase low-carbon and highly efficient fuels, each time they refuel, can shape demand. These taxation systems raise customer awareness of the cost of carbon and provide a political signal that society attaches a priority to reducing CO_2 emissions.

For example, diesel vehicles are 20% to 40% more efficient than conventional gasoline vehicles. However, clean diesel vehicles make up less than 3% of the market in the United States compared to 50% in Europe. This is due to the fact that tax policies are largely different, with fuel prices in Europe substantially higher than in the US, and with European consumers therefore more sensitive to fuel consumption; in addition, several European countries tax gasoline at a higher rate than diesel fuel. The results are vastly different fleet compositions.

Tax measures can help create a market for breakthrough technologies, notably during the introduction phase. Innovations generally first enter the market in low volumes and at a significant cost premium, and this needs to be offset by a positive policy framework.

Consumers can be influenced to purchase more efficient vehicles through adequate fiscal policies, including the temporary use of tax incentives, which give consumers a financial reward for buying a more efficient vehicle. In addition to improving the environmental performance of the current fleet, such fiscal policies can encourage reductions in transportation energy use and emissions by accelerating the development of lower emissions technologies. A variety of fiscal policies have been used to support the purchase of higher efficiency vehicles by individuals, business and governments. Some strategies include :

- Rebates, tax credits and tax deductions for the purchase of highly efficient vehicles;
- Reduced sales and excise taxes; and
- Scaled vehicle registration charges based on emissions rates.

One recent study found that in 2006, the first year of a US program providing tax credits to hybrid vehicle purchasers, the incentives produced a 20% increase in hybrid sales compared to what the expected sales would have been without the tax credit. Researchers expect the program could save 1.8 million barrels of oil and avoid 760 000 tons of CO_2 emissions over the lifetime of the vehicles involved[5]. Automakers believe a technology neutral measure, focusing on actual performance rather than particular technologies is expected to yield even better results.

5 Source : Beresteanu, A. and Li, Shanjun, "Gasoline Prices, Government Support, and Demand for Hybrid Vehicles in the US," Resources for the Future, Washington D.C., 2009

In the EU, after studying how consumers use their vehicles, policymakers concluded that car taxation systems totally or partly based on the vehicle's CO_2 emissions and/or fuel consumption can help reduce vehicle CO_2 emissions in certain EU markets. As a result, over the past four years, the number of member states with CO_2 related taxation schemes has risen from 9 to 17.

Examples of existing CO_2 related taxation systems are multiple. However the cases of Norway and Austria are worth noting since their relatively early introduction allowed experience to be gained.

NORWAY: The local passenger car import taxation based on CO_2 emission, applied since January 2007, led to a **decrease of average CO_2 from 172 g/km to 152 g/km** (for passenger cars)[6].

AUSTRIA: An exhaust emission-related taxation called "NoVA" has been updated in 2008[7]. As from 1 July 2008, the emission tax for cars with a CO_2 emission lower than 120 g/km was reduced by 300€ compared to 2007 values. For cars with a CO_2 emission higher than 180 g/km the tax was increased by 25€ per g/km exceeding 160 g/km. The "greening" of the NoVA tax as a measure to promote purchasing of clean and low-consuming vehicles showed positive effects. The average CO_2 emission of new registered cars in 2008 (300 000 cars, 45% gasoline, 55% diesel) amounted to 155 g/km for gasoline vehicles and 160 g/km for diesel vehicles, i.e. 157.7 g/km in average, around 5 g/km less than the average for vehicles registered in the preceding year (2007).

3. TRAFFIC FLOW IMPROVEMENT

A second pillar of the integrated approach, besides vehicle technology and fleet renewal, relates to the way the vehicles are used on the road.

In many countries and cities, congestion is an important factor. For example, in 2008 the Italian Ministry of Transport and Infrastructure calculated that the economical cost of congestion in Italy amounts to 19 billion euro every year. It is equally clear, as will also be shown in the following examples, that free flowing traffic is much more efficient from all points of view, including fuel consumption and CO_2 emission, than a congested traffic.

FRANCE: a study made by Renault showed the effects of traffic flow speed on fuel consumption and CO_2 emissions: in conditions of free flowing traffic (at a speed of about 70 km/h), fuel consumption and CO_2 emissions are lower by **about 25%** than in a situation of strong congestion (about 30 km/h)[8].

Low traffic speed leading to increased CO_2. Assessment for diesel passenger cars:

Fuel consumption and CO_2 emissions for 100 km	
70 km/h	5.6 litres (15.1 Kg CO_2)
50 km/h	5.6 litres (15.1 Kg CO_2)
30 km/h	7 litres (18.9 Kg CO_2)

GERMANY: A study[9] was made in the Stuttgart area by DEKRA, comparing the same trip of 42 km between "best" and "worst" conditions. The results indisputably showed that the **fuel consumption, and consequently the CO_2 emissions of vehicles, was reduced by 25%** when doing the trip without major congestion, compared to situations of traffic jam.

Sources :

6 - The Norwegian Road Federation (www.ofvas.no).

7 - Normverbrauchsabgabegesetzes (NoVA), published on 28/02/2008, BGBl 46/part I

8 - Renault

9 - DEKRA Automobil GmbH, 12. 7. 07, Verbrauchsmessfahrt in Stuttgart, 20-6-2007

High traffic jams cause a strong growth of consumption and CO_2 emissions.
DEKRA's study findings:

	Best	Worst
Journey time	1h 14 min	1h 48 min
Km	42	42
Red traffic light	23	34
Green traffic light	26	15
Average speed (km/h)	35	24
Total consumption (l)	2.52 l	3.36 l
Average consumption (l/100km)	6	8
CO_2 emission (g/km)	159	212
Tot. CO_2 emission (kg)	6 678	8 904

USA: In 2007, congestion caused urban Americans to spend an additional 4.2 billion hours travelling and to purchase 2.8 billion gallons (or approximately 10.5 billion litres) of fuel, which produced 24.6 metric tons of CO_2. This amounts to an effective "congestion tax" imposed on the economy of $87 billion, an increase of more than 50% than the previous decade[10].

The above examples clearly show the benefits of free flowing traffic compared to congestion.
As the studies in France and Germany clearly show, reduction of congestion has the potential to reduce fuel consumption and CO_2 emissions by at least 25%.

Congestion mitigation policies therefore clearly play a role in reducing CO_2 emissions from road transport, especially taking into account that these affect not only new vehicles, but even more importantly the existing vehicle fleets.

In addition, while it takes many years for new technologies to penetrate the market and to replace the old, less efficient vehicle fleet, congestion mitigation measures have an immediate effect. This means that improvements to the traffic flow, to ensure more constant speeds, show immediate and efficient CO_2 savings.

Ways and means must therefore be found in order to achieve such improved traffic flows. This study shows that quite some experience exists worldwide in this respect and that several tools are at the disposal of policy makers. The measures analysed in this chapter relate to:

- infrastructure measures
- intelligent transportation
- road transport logistics
- fiscal measures
- car pooling/car sharing and mobility plans

• Infrastructure measures

Infrastructure improvement measures can take many forms, from a very local simple improvement, up to the creation of new roads, especially bypass roads, able to divert part of the traffic flow away from the city centres.

10 Source : Schrank, D. and Lomax, T. 2009. The 2009 Annual Urban Motility Report. College Station, Texas: Texas Transportation Institute. http://mobility.tamu.edu/ums/report, July

Some detailed investigations on the net effect on CO_2 emissions have been made, as described below.

JAPAN: One particular study reviewed the effectiveness of some infrastructure upgrades in the Tokyo area[11], with impressive results in terms of CO_2 reduction, thanks to the elimination of bottlenecks and the improvement of the traffic flow:

Elevation of 150 downtown railway crossings → CO_2 emissions down by 800 000 tons/year

Completion of Tokyo's three major ring roads → CO_2 emissions down by 700 000 tons/year

Still in Japan, many initiatives have been taken to improve road infrastructure (i.e. addition of traffic lanes and overhead crossings), and official sources have estimated the following results[12]:

Place	Measure	CO_2 emission reduction
Hokkaido Pref. Sapporo City	Added lanes at the exit of the expressway interchange, and also added an outflow lane on the national highway, connected to this exit	**370 tons/year** (13% reduction/previous year)
Akita Pref. Yurihonjo City	Added right turn lane and controlled traffic lights at intersection on city road with traffic congestion	**66.1 tons/year** (18% reduction/previous year)
Yamagata Pref. Yamagata City	Overhead crossing at point of biggest traffic congestion in the city	**1 500 tons/year** (11% reduction/previous year)
Miyagi Pref. Sendai City	Eliminated 10 railroad crossings in the city	**500 tons/year**
Niigata Pref. Joetsu City	Added right turn lane at point of junction of bypass and national highway	**230 tons/year** (2% reduction/previous year)
Toyama Pref. Toyooka City	Overhead crossing at point of traffic congestion	**1 400 tons/year** (30% reduction/previous year)
Ishikawa Pref. Kanazawa City	Overhead crossing at point of traffic congestion	**765 tons/year** (9% reduction/previous year)
Ibaraki Pref. Takahagi City	Eliminated a railroad crossing on national highway	**60 tons/year**
Saitama Pref. Kumagaya City	Overhead crossing at point of traffic congestion	**750 tons/year**
Chiba Pref. Ichikawa City	Overhead crossing at point of traffic congestion	**1 800 tons/year**
Tokyo Pref. Edogawa-ku	Overhead crossing at intersection of arterial highways with traffic congestion	**3 900 tons/year**
Ehime Pref. Matsuyama City	Overhead crossing at point of biggest traffic congestion in the city	**408 tons/year** (30% reduction/previous year)
Saga Pref. Saga City	Added lanes at intersection with traffic congestion	**111 tons/year** (8% reduction/previous year)
Nagasaki Pref. Isahaya City	Overhead crossing at point of biggest traffic congestion in the city	**250 tons/year**

Sources :

11 - JAMA 2009

12 - Ministry of Land, Infrastructure, Transport and Tourism http://www.mlit.go.jp/road/koka6/4/4-1.html et al.

The above local improvements therefore result in a CO_2 saving of more than 12 000 tons every year! This represents the fuel consumption of almost 9 000 cars every year (assuming vehicles emitting 140 g CO_2/km and driven 10 000 km annually), taking into account that these few local measures represent only a small fraction of the benefits which could be gained by a systematic approach to infrastructure improvement.

USA: A detailed study showed that modest improvements to unclog traffic flow at 233 severe bottlenecks on the nation's highways would conserve, over the 20-year life of the projects, more than 151 billion litres of fuel; carbon dioxide emissions would drop by an impressive 77% at these bottlenecks. Similar impressive figures were calculated in terms of vehicle accidents, fatalities and injuries, pollutant emissions, and commuting times[13].

Infrastructure measures do not necessarily entail heavy construction work, but can also address changes to the use of the existing roads. As an example, in FRANCE, an official study over two years concluded that the use of emergency lane as "rush hour lane" in the peak times would lead to **a reduction of CO_2 emissions by 4.25%**[14].

• Intelligent transportation

Intelligent Transport Systems are getting increasing attention. The whole concept of ITS is very wide and complex, but one of the key purposes of ITS is to improve road traffic in terms of safety, in terms of efficiency and, last but not least, in terms of the environment.

There is general recognition that making the transport systems "smarter" may yield substantial benefits. Elements of such "smart transport" include, but are not limited to, intelligent traffic lights, electronic tolling systems (ETC), on-board systems of traffic information and guidance, etc.

The following few examples highlight the achieved or expected CO_2 reductions thanks to such improvements.

"Smart" transport / advanced traffic management systems to reduce traffic congestion

GERMANY: A **steering system for traffic lights according to the traffic situation** has been installed on the Ring 2 – road in the city of **Hamburg**. This measure led to a reduction of **1 300 tons CO_2 per year**[15].

Still in Germany, according to a study on the effects of **advanced traffic management systems** made in **Cologne** (year 2000)[16], reduction in CO_2 emissions is as follows:

System	CO_2 saving (tons p.a.)
Parking guidance system	3 000
Park + ride guidance system	400
Park + ride information on arterial roads	1 800

Sources :
13 - American Highway Users Alliance http://www.highways.org/pdfs/bottleneck2004.pdf
14 - Regional Transport Authority and INRETS, National Transport Research Institute
15 - Baum, Herbert: CO_2-Effekte von Informations- und Kommunikationstechnologien, Survey for VDA, Köln 2007
16 - Baum, Herbert: Programm Verkehrstechnik Köln - Entlastungswirkungen des Verkehrsmanagementsystems im Kölner Stadtverkehr, Köln 2000

JAPAN strongly promotes information and communications technology in transport infrastructure and vehicles in order to cut emissions, transportation times, and fuel consumption.
Two main technologies are currently in place:

■ **VICS (Vehicle Information and Communication System)** is a digital data communication system which provides road traffic information in real time[17]. VICS-centres gather road traffic information and transmit it to the car navigation equipment.Thus drivers are informed in real time of the traffic situation, and may consequently avoid congested roads and select an alternative route. This system therefore facilitates smooth traffic and higher travel speed, and consequently a cut on noxious emissions.

CO_2 saving: 2.4 million tons CO_2 in 2010

According to official data[18], VICS will allow in 2010 the avoidance of almost 2.5 million tons of CO_2 on the roads in Japan.

Noteworthy is the fact that the effects of VICS can be further enhanced by real-time provision of information on parking space or even public transport availability.

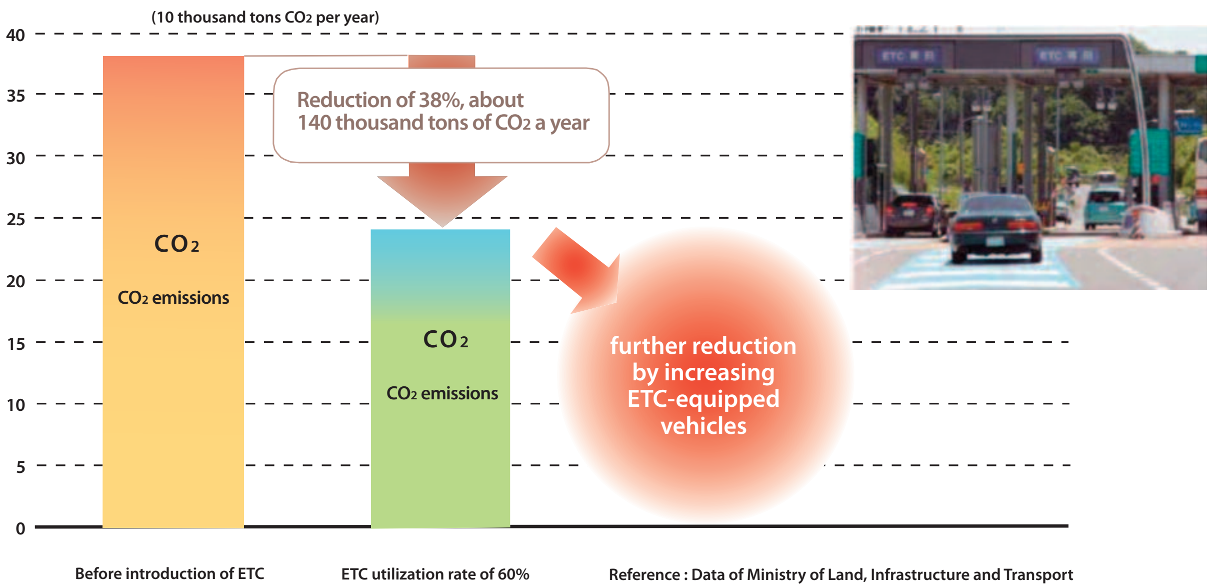
■ **ETC (Electronic Toll collection)** allows charging tolls without vehicles having to stop for payment. ETC can therefore greatly improve traffic flow at toll gates, wherever these are located, with consequently a reduction in emissions and noise.

CO_2 saving: 200 000 tons CO_2 in 2010

In 2007, already 68% of the vehicles on the road were equipped with ETC in Japan.
A detailed study[19] came to the conclusion that, when the percentage reached 60% in June 2006, **CO_2 emissions were reduced by 38% in the whole country, or about 140 thousand tons every year**[20]. The Japanese government estimates that in 2010, the avoided CO_2 thanks to the Electronic Toll Collect system will increase to 200 thousand tons. Road-transport CO_2 emissions could be reduced by 1 million tons annually if ETC is used by 80% of all drivers.

Sources :
17 - http://www.vics.or.jp/english/about/history.html
18 - "Integrated Approach" by Office of Climate Change - Environment Division - Road Transport Bureau - Ministry of Land, Infrastructure, Transport and Tourism, page 9
19 - ITS Handbook - Japan 2007-2008, page 92
20 - www.hido.or.jp/itsos/ 4. ETC in Japan.pdf

ETC utilization rate and reduction in CO_2 emissions (estimated results)



FRANCE: Similarly to the data for Japan, a study provided by local motorways companies shows that if all toll gate transactions on the motorways were achieved in free flow in France, **1 million tons CO_2 per year (on a total of 23 million tons for motorway traffic in France)** would be saved **(-4.3%)**[21].

KOREA: It is estimated that the use of electronic toll collection system on the Seoul Ring Expressway can avoid **100 thousand tons of CO_2** over the following 10 years[22].

• Road transport logistics

Especially in freight distribution, several measures can be taken, as part of an efficient fleet management system, to reduce traffic congestion, i.e. avoiding unnecessary freight movements through urban areas.

As an example, modular long distance transport (i.e. adoption of longer trucks) may ensure efficient transportation of the same quantity of goods by fewer trucks; this means that, for the same quantity of goods, a lower number of trucks would be on the road at the same time, resulting in less traffic congestion.

Several studies have already been made on the effectiveness of a re-organization of road transport, as summarized below.

Longer and/or larger goods vehicles for long distance transport

EU: A study called "Effects of adapting the rules on weights and dimensions of heavy commercial vehicles as established within Directive 96/53/EC", carried out for the Directorate-General for Energy and Transport in the European Commission, analyses the effects of adapting the rules on weight and dimensions of heavy commercial vehicles within Directive 96/53/EC. The main conclusions are that, in the full options scenario, using long heavy vehicles of 25.25 m and 60 tons circulating throughout the European Union, would imply a CO_2 emission reduction **by 3.58%**[23].

Sources :

21 - CCFA 2009

22 - Korea Expressway Corporation, Report on the Effect of Hi-Pass, April 2008

23 - European Commission, Directorate-General Energy and Transport - Unit Logistics, Innovation & Comodality, "FINAL REPORT - Effects of adapting the rules on weights and dimensions of heavy commercial vehicles as established within Directive 96/53/EC", page 123

GERMANY: A field trial made in **Germany** by a transport company with one 25.25 m - combination over nine months showed that the number of kilometres driven for the same transport services went down by 70 000 kilometres and led to a **reduction in CO_2 emissions by about 20%**[24].

NETHERLANDS: In the Netherlands, several trials of longer vehicle combinations on Dutch motorways during recent years (1999-2003, 2004-2007) have concluded that, by replacing 8 000 heavy trucks (7% of the fleet) by 6 000 EMS (European Modular System) vehicles, CO_2 emissions are reduced by between 3% and 5.7% (depending on driving conditions)[25].

JAPAN: According to a Japanese study on the Integrated Approach presented at COP15 Copenhagen in 2009, more efficient freight logistics enabled the saving of **about 18.6 million tons of CO_2 emissions**[26], representing the CO_2 emissions of almost 14 million cars annually. This could be achieved through increased deployment of larger-size (24-25 tons) trucks (from 80 000 trucks in 2002 to 150 000 in 2007), as well as additional reorganization measures for the freight transport system.

Reorganization of transport

The road transport chain may also be re-organized in order to ensure that the most efficient road transport mode is used depending on the route to be followed. The example of France, as explained below, shows that remarkable reductions of CO_2 emissions can be achieved, while maintaining freight transport as a viable economic activity.

FRANCE: So called Urban Distribution Centres (CDU for "Centre de Développement Urbain") have been set up, consisting of freight platforms in which long-distance freight is collected and then dispatched by smaller, electric vehicles within city centres where heavy duty vehicles are forbidden.

There are two main examples of CDUs:
The first assessment has been conducted in the city of La Rochelle in 2002, and has led to a **CO_2 reduction of 61%**:

CDU in La Rochelle (assessment conducted in 2002)

Surface of CDU	700 m^2
Territory	200 ha
Operating company	Interurban road transport company
Vehicle fleet	6 electric small vans (Citroën Berlingo), 1 electric LCV (3.5 t) and 1 diesel LCV (3.5 t)
Rules	Deliveries forbidden for vehicle >3.5 t
Freight volume	72 477 parcels delivered in 2002 (1 636 tons of freight)
Public incentive	54 000€ in 2002
Environmental impact:	
CO_2 emissions	- 61%

Sources :
24 - Meyer & Meyer
25 - CCFA 2009
26 - “Integrated Approach, Pass for sustainable future of transport”, Akihiko HOSHI, MLIT, Japan, 2009
http://drivingsustainability.com/files/DrivingSustainability_Hoshi.pdf

In 1989, an urban distribution centre of 1 300 m² was introduced in Monaco to optimize freight distribution and reduce congestion. It consists of a freight platform at the disposal of transport operators to move all kinds of freight (except specific goods such as removals, perishables or fuel) to and from Monaco. It is located at the entrance of Monaco, which limits transit. The use of this platform is compulsory for vehicles over 8.5 tons and optional for lighter vehicles.

This second impact assessment has been conducted by the government of Monaco and the French environmental agency (ADEME) in 2002. It showed that it resulted in a **26% decrease in fuel consumption and CO_2 emissions**[27].

CDU in Monaco

Surface of CDU	1 300 m²
Territory	195 ha
Operating company	Logistics company
Vehicle fleet	3 LCVs (3.5t), 1 truck (7.5t)
Rules	Deliveries forbidden for vehicle >8.5 t
Freight volume	82 563 parcels delivered in 2002
Public incentive	86 000 € in 2002
Market distribution	14 operators account for 88% of moved parcels or pallets and 94% of customers
Environmental impact: CO_2 emissions	- 26%

Co-modality

Road transport for freight is and will remain a necessity from a social as well as from an economic point of view. It must however be recognized that, depending on the situation, part of the complete transport chain may be taken over by other than road transport systems: not all goods will necessarily have to be transported from point A (starting point) to point B (final destination point) by road only: part of that transport chain may well be efficiently taken up by other transport operators (maritime transport, rail transport). In order to establish such intermodal transport chains, links between different modes must be optimised.

• Fiscal measures

Direct CO_2 - related taxation systems, aimed at vehicle ownership, may affect consumer purchase decisions and thereby influence fleet renewal, as described above.

However, when it comes to vehicle use and traffic flow improvement, other fiscal measures may directly affect the actual usage of vehicles. Currently there are charging schemes in place in some cities (e.g. London, Milan and Stockholm), to reduce traffic in the city centres. It should however be stressed that these schemes were originally put in place in order to give local answers to purely local problems (air quality, congestion).
They were not primarily intended to address CO_2 issues and their application on a wider scale is and remains very questionable (e.g. due to high system costs).

27 Source : Ademe. See also http://www.transports-marchandises-en-ville.org/article.php3?id_article=18

As a general remark, one could imagine fiscal measures geared towards taxing vehicle use rather than ownership in order to influence consumer behaviour and vehicle use pattern, with the aim to improve traffic flow. However, a precondition for such a scheme would be that it remains overall cost-neutral for the car-driver. Taxes on use should replace existing taxes based on vehicle purchase or ownership and should not simply be additional.

• Car pooling/car sharing and mobility plans

The introduction in the cities of car pooling/car sharing programs, and programs to encourage company employees to use transport (public transport, car sharing/car pooling…) allow several benefits for the community, especially in the highly congested areas of the cities, as shown by the following examples:

FRANCE: In Paris, a company called "Caisse-commune" launched in 1999 an initiative of self-service car fleet. Users can subscribe to this service against an annual fee and an additional fee depending on their use of the cars. (1 500 users, 50 vehicles and 8 stations). Generally the cars used for this service are very new and fuel-efficient. The estimated result of this experiment is **1 290 tons of CO_2 saved each year**[28].

A manufacturer has for instance launched a PDE (Plans de Déplacements d'Entreprise) about ten years ago in its "Technocentre" (12 000 employees, 150 hectares) to improve the existing transport offering (parking, car-pooling between employees, specific public transport services, incentives…) to give them the opportunity to choose their mode of transport according to their needs. The estimated result is **2 300 tons of CO_2 saved each year**[29].

AUSTRIA: The Ministry for Environment reported that in 2009 the special program called "Klima: aktiv mobil" was implemented, in the form of actions and advices to improve mobility management for several target groups (enterprises, public administrations, students, elderly, tourists, etc.). About 700 active partners joined this program, which resulted in an annual total saving of **325 000 tons CO_2**, consisting of:

- 120 000 tons CO_2 (change in vehicle fleets with the primary aim to gain CO_2 reductions)
- 132 000 tons CO_2 (specific mobility management projects)
- 49 000 tons CO_2 (bicycle projects substituting other transport systems)
- 24 000 tons CO_2 (special education for drivers to save fuel)[30].

Worksite-based carpool matching programs have long been a staple of transportation demand management initiatives. Only very recently, however, has technology evolved to the point of allowing "real-time" formation of carpools, including for non-work and irregularly scheduled trips; we are now witnessing rapid innovations in this area.

USA: As an for example, NuRide runs a free, on-line, ride matching service as part of a larger incentive based program that rewards members for "green trips"; the service had nearly 40 000 members as of February 2009. Transit agencies are increasingly adopting web-based trip planners that give travellers detailed information on their alternatives given an origin, destination, and start or end time. Private services such as Google and SmarTraveler also have ventured into the realm of providing transit information, but to date have been limited by the availability of underlying data provided by transit agencies.

Sources :

28 - CCFA 2009

29 - Renault

30 - Austrian Ministry of Environment, www.klimaaktivmobil.at, report by Mr. Robert Thaler (Ministry of Environment)

16 GoLoco is a Facebook-based ride matching service in which travellers split costs. PickupPal, a free on-line ridesharing service based in Ontario and launched in early 2008, had 100 000 users in 60 countries around the world as of September 2008. The service focuses on casual carpooling for special events; users can enter their start and end point and be matched with other users with similar itineraries. At least nine US online ridesharing sites were operating as of February 2009, in addition to numerous regional sites[31].

4. ECO-DRIVING

When it comes to the actual use of vehicles, i.e. the way they are driven on the road, driving behaviour can have a very strong impact on CO_2 abatement.

By changing the driving style, significant results can be obtained. The "environmentally friendly driving style", or eco-driving, is a driving technique that allows significant reductions in fuel consumption and in CO_2 emissions.

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The most important rules are:

- Keep an uniform pace without violent braking and acceleration
- Predict traffic trend (i.e.: don't accelerate close to queues or red lights)
- Keep in high gears when possible
- Avoid overtaking
- Check tyres pressures
- Avoid heavy loads if unnecessary and remove everything that can disturb vehicle aerodynamics

The most important benefits are in the reduction of:

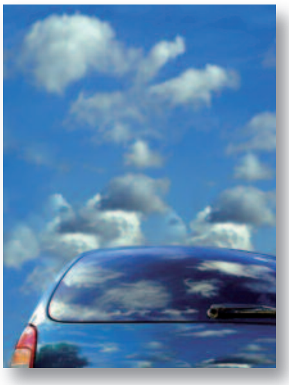
- Fuel consumption / CO_2 emissions
- Vehicle maintenance costs
- Stress
- Noise nuisance
- Local air pollutants

Eco-driving presents several key advantages:

– It is highly cost-effective, and even cost-beneficial: consumers reduce their fuel consumption, and therefore their costs, without any investment.
– It is immediately applicable without any delay of implementation.
– It is potentially applicable to the complete existing vehicle fleet, if all drivers can be persuaded to adopt eco-driving techniques.
– It is easy to implement.
– It immediately results in remarkable improvements not only of environmental but also of comfort and road safety aspects.

31 **Source** : Report to Congress, US Department of Transportation - Transportation's Role in Reducing US Greenhouse Gas Emissions Volume 1: Synthesis Report. April 2010

In several countries eco-driving programmes are embedded in their climate change policies, e.g. in Austria, in the Netherlands and in Spain, as a substantial contribution to meeting Kyoto and other air quality targets.



• Assessment and results of eco-driving programmes

Several studies demonstrate the usefulness of eco-driving and everyone can experience the benefits in their daily driving habits.

OECD: In the framework of OECD, the International Energy Agency and the International Transport Forum held a special international workshop in 2007. This workshop showed that eco-driving can deliver high CO_2 reduction in a quick and cost-effective way,and concluded that eco-driving has the potential to reduce CO_2 emission on average by10%[32], this figure even possibly rising to 50% depending on the individual driver.

Similar figures of CO_2 emissions decrease by about 10% through eco-driving were also found in other studies, such as in **JAPAN**[33] and **SWEDEN**[34]. The European Automobile Manufacturers Association ACEA concluded that eco-driving can reduce CO_2 emissions by around **25% in the short term and 7% in the long term**[35].

Several detailed studies were also carried out and achieved detailed figures in terms of concrete results and detailed eco-driving measures.

Already in 2001, **EECP** (the European Climate Change Programme) calculated a potential for driver re-education and eco-driving of at least 50 million tons CO_2 emission reduction in Europe by 2010. This would mean savings for consumers of about 20 billion euro per year[36].

FRANCE: A study shows some effects linked with eco-driving issues:

- Under-inflated tyres cause fuel consumption to increase by approximately 3% with a pressure reduction of only 0.3 bars.
- Driving with a roof rack also leads to excess fuel consumption, which varies from 10% for an empty rack to 15% for a full rack. At 120 km/h, this 15% costs one litre of fuel over 100 km.

SWITZERLAND: The yearly Report of "Quality Alliance Eco-Drive" for 2007 shows that eco-driving allowed a saving of **46 797 tons of CO_2** in the year of application, thanks to a participation of 36 531 people in eco-driving training[37].

NETHERLANDS: The Dutch national eco-driving programme "Het Nieuwe Rijden" results from the Kyoto agreement and from national policy documents. The programme concerns a long-term strategy for the period 1999 until 2010, evaluated annually. The target is a CO_2 emission avoidance of 1.5 million tons in 2010[38], with a cost-effectiveness of 7€ per ton CO_2 saved.

Sources :

32 - IEA&ITF Workshop on Ecodriving, Paris 2007
http://www.iea.org/work/2007/ecodriving/ecodrivingworkshopfindings_en.pdf

33 - JAMA, "Reducing CO_2 emissions in the global transport sector", page 10

34 - JAMA, "Reducing CO_2 emissions in the global transport sector", page 10

35 - http://www.acea.be/index.php/news/news_detail/acea_test_your_eco_driving_skills

36 - http://www.ecodrive.org/Benefits-of-ecodriving.277.0.html

37 - "Quality Alliance Eco-Drive" for 2007

38 - http://www.nieuwerijden.nl/english.html

These are the obtained results[39]:

– Result in 2005: 0.5 million tons CO_2
– Result in 2006: 0.6 million tons CO_2

Manufacturers support the eco-driving concept and equip many current vehicles with systems to help drivers adapt their driving style toward eco-driving. Manufacturers also set up training programs, aimed at both experienced and inexperienced drivers, that promote eco-driving.

GERMANY: Since 1998, a manufacturer developed the training program "Eco-driving" with the German Federation of Driving Instructor Associations and the German Road Safety Council. The test led to a **saving by 25%** in terms of fuel and CO_2 emission reduction[40].

ITALY: The application of the "eco:Drive" system, developed by a manufacturer and applied in one year (2008) on 33 000 vehicles, led to a total CO_2 cut of 2 650 tons[41].
Through a USB key, information about the vehicle and the driver behaviour is collected during the drive time and then downloaded on to a personal computer. Specific software analyses the driving efficiency and provides an eco:Index that suggests how to modify the personal behaviours to obtain a more environmentally friendly driving style.

5. CONCLUSION

The automobile industry recognizes that road transport is a relatively important contributor to CO_2 emissions.

At the same time, however, road transport plays a key role in our modern societies: without road transport, the economies would simply collapse and the world we live in would be drastically changed. Road transport is essential, not only to respond to the economic demand in terms of goods and materials, but also to satisfy the justified demand for individual mobility.

Manufacturing of vehicles provides, directly or indirectly, tens of millions of jobs and is therefore a major contribution to our economic welfare.

It is therefore essential to ensure that the most efficient approach, or approaches, are used when it comes to the reduction of CO_2 emissions by the road transport.

Sources :

39 - "Evaluation and monitoring as an instrument for policy-decision-making", pages 3-6, Paris, IEA and ITF Eco-Drive Workshop , 23 november 2007,– Ministerie van Verkeer en Waterstraat

40 - "Ford Eco-Driving", Ford Germany reported by "Impact of in-car instruments on driver behaviour", page 13, Paris, IEA and ITF Eco-Drive Workshop, 23 November 2007

41 - System based on the Blue&Me Platform, created by Fiat Group Automobiles and Microsoft Automotive Business Unit

The automobile industry is firmly convinced that only an integrated approach provides such efficiency, combining all stakeholders, not only the vehicle manufacturers, but also the fuel industry, governments and consumers. The integrated approach therefore does not only address the vehicles themselves, but also the way they are used on our roads.

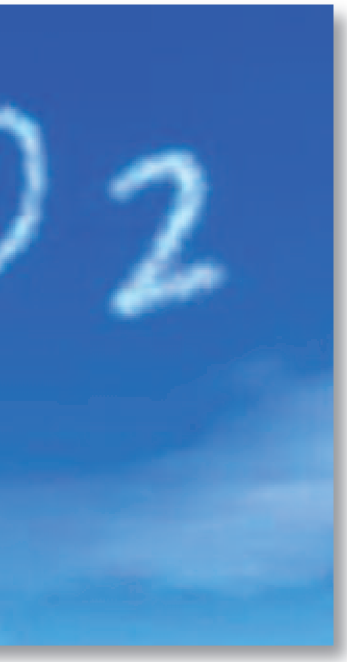
Vehicle technology obviously is one of the pillars of such an integrated approach and manufacturers are demonstrating every day that they are seriously committed in offering new technologies. Today's vehicles are many times more efficient in terms of safety, environmental performance, driving comfort, reliability, etc. than just a few years ago and progress is continuing. Not only are vehicle manufacturers continuing to improve the efficiency of current propulsion systems, they are also investing massive amounts in the development of new alternative concepts which will shape the road transport of the future. These new technologies include, but are not limited to, hybrids, battery electric vehicles, fuel cell vehicles; other technologies explore the use of alternative fuels (e.g. biofuels, biogas, hydrogen, etc). Clearly a close cooperation with and commitment by the fuel industry is therefore needed since vehicles and the fuel they use are to be treated as a system.

Vehicle technology (and the fuel that goes with it) can therefore provide at least a partial answer, but for this, the conditions must be in place to enable these technologies to enter the market. In many countries, the existing vehicle fleet is very old, sometimes more than 15 years, and governments have an important role to play to ensure that the fleet is renewed. In particular, the new vehicles must remain affordable for the consumers: policies that dictate extremely sophisticated technologies without taking into account other considerations run the risk of obtaining exactly the contrary result, namely that owners keep their existing vehicles longer, with the inherent negative consequences for the environment or for road safety. This question may become even more acute in less developed economies, where the existing fleet is the oldest, such that the situation may become a vicious circle.

Overall, it is clear that the various scrapping schemes in place in several countries in order to stimulate the economy and sustain the automotive market during the economical crisis have had a very positive effect to accelerate the replacement of the old vehicles by new, modern, safe and fuel efficient vehicles.

The schemes in place have showed a high efficiency over the short to medium term but can, in the automobile industry's opinion, not replace over the long term the natural market tendencies; such incentive schemes should be sufficiently stable in time, but should ultimately disappear, in order to guarantee the functioning of a free and open market. Incentives are not there to promote particular technologies, but must remain performance oriented. Governments have consequently a crucial role to play to maintain a free market, while putting in place the necessary policies and safeguard and control procedures.

When designed appropriately, for example CO_2 based vehicle taxation can provide incentives for fleet renewal and can create demand for fuel-efficient vehicles.



A second pillar of the integrated approach aims at traffic congestion. It is clear that the energy consumption of a vehicle is substantially higher in congested traffic than under free flowing conditions. Many tools exist to improve the situation in congested areas and the available studies show the efficiency of these tools, which can range from simple or complex traffic management using the existing infrastructure up to the construction of additional infrastructure. These tools may be for local, or more widespread application.
The collected data in any case demonstrate that improving the infrastructure efficiency, elimination or simply reduction of bottlenecks, better road traffic information to enable alternative routes, park and ride facilities, etc, can drastically reduce on an ongoing basis the CO_2 emissions from road traffic.

Particularly interesting is that facilitating traffic flow addresses the complete vehicle fleet at once, with immediate result without having to wait for the parc renewal.

Thirdly, vehicle users have an important role to play since plenty of data exist showing how, for the same vehicle, using the same route, driving behaviour can have a crucial importance, with eco-driving entailing up to 25% fuel consumption reduction. Even the most fuel efficient vehicle would see its fuel consumption suffer from an aggressive drive style, while simple driving skills allow the driver to reap all the advantages from his vehicle. A more environmentally friendly drive style can be applied very easily and could be part of the driving courses for new drivers as well as of regular information campaigns. Drivers would immediately recognize the benefits when they see their fuel bills reduced substantially!

This short study in conclusion shows that a toolbox exists to reduce the CO_2 emissions from road traffic. The tools in this box are multiple and probably no single one is able on its own to give the complete answer. However, all these tools of the "integrated approach" can be used, to one extent or another, in order to adopt the most cost/efficient measures from a society point of view to reach sustainable mobility, preserving the environment and the economical reality at the same time.

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