Clean Vehicles in Europe

An owerview of vehicles, fuels and national strategies

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Summary in english

This report is a compilation of data, mainly from specific reports and interviews. The report gives an overview of the present alternatives to petrol and diesel, i.e. alternative fuels or Clean fuels. The report also gives state of art of the Clean Vehicle situation in some European countries. Clean Vehicles are fuelled by renewable fuels or fossil fuels that are less pollutant than ordinary fuels, or use a technique, which dramatically reduce pollution and energy use.

The most common renewable fuels in Europe are Biodiesel (vegetable oil) and Ethanol. Biodiesel production has increased about 10 times the last 10 years and Europe is now the world's biggest producer and user of biodiesel, consuming about 1,2 Millions m^3 per year. Also Ethanol production has raised, by a factor 5, to about 0,3 Millions m^3 per year Compared to the biggest Ethanol users Brasilia (12 Mm^3/year) and USA (6,7 Mm^3/year), Europe still is rather undeveloped in this aspect. Biogas is a fuel that is just beginning to be used and has a big potential.

Fossil fuels that are regarded as clean are i.a. Natural gas and Propane (LPG). Fuel cell vehicles driven by Hydrogen may be the future clean vehicle but is still not commercially available.

The policies for Clean vehicles and fuels are significantly different in different countries in Europe, which creates a barrier for large-scale use of biofuels. Neither is there a common definition of Clean Vehicles. The European Council has implemented an Alternative fuels Directive which aims to increase the use of renewable fuels in the Member States, with the objective to reach 5,75 % the year 2010. The objective is however not compulsory.

Clean Vehicles and Clean Fuels are still more expensive than ordinary. There are different policies to support the introduction of Clean Vehicles in Europe. The most successful seems to be tax relieves combined with subsidies for production of fuels and local incentives like reduced parking fee and parking lots dedicated exclusively to Clean Vehicles.

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Target groups: Policymakers at local and national level and others interested in a broad overview of the present status regarding clean vehicles and alternative fuels in Europa.

FOREWORD

The spontaneous development of transport in Europe is not sustainable. To change this it is necessary to mobilise and present a carefully chosen combination of measures that cover several areas and involve various responsibilities in the cities rather than a list of isolated efforts. In other words, to have an integrated approach.

The European project TRENDSETTER involves 50 individual projects, all of which aim to; improve mobility, quality of life, air quality, and reduce noise and traffic congestion. The cities of Stockholm, Lille, Graz, Prague and Pécs co-operate in the project to ensure real impact, by setting good examples and encouraging others to follow.

More information is available at http://www.trendsetter-europe.org

This report is produced within the framework of the Trendsetter project. It is a summary of European experiences of Biogas, with a focus on the use as a vehicle fuel. It highlights the lack of European legislation and regulation as a major barrier to the further development of biogas use, but also presents some examples of best practise and provides a guide for cities interested in producing and upgrading biogas.

The report has been compiled by Charlotte Plombin, Engineering student at the Ecole des Mines d´Albi, France, as a part of her internship at Stockholm Environment Administration. Project Manager Jonas Ericson at Stockholm Environment Administration, supervised the work.

Stockholm, August 2003

Gustaf Landahl
Project Co-ordinator

SUMMARY

The fossil oil is not unlimited. The environmental problems caused by the traffic are increasing, and traffic is now the main source for pollution like NO_x, Particles and Carbohydrates. Traffic pollution in Stockholm reduces lifetime as much as Traffic accidents do. Furthermore, fossil fuels are contributing strongly to the greenhouse effect.

One way to reduce the problems caused by traffic is to replace ordinary Vehicles with Clean Vehicles. Such vehicles are fuelled by renewable fuels or fossil fuels that are less pollutant than ordinary fuels, or use a technique, which dramatically reduce pollution and energy use.

The most common renewable fuels in Europe are Biodiesel (vegetable oil) and Ethanol. Biodiesel production has increased about 10 times the last 10 years and Europe is now the world's biggest producer and user of biodiesel, consuming about 1,2 Millions m^3 per year. Also Ethanol production has raised, by a factor 5, to about 0,3 Millions m^3 per year Compared to the biggest Ethanol users Brasilia (12 Mm^3/year) and USA (6,7 Mm^3/year), Europe still is rather undeveloped in this aspect. Biogas is a fuel that is just beginning to be used and has a big potential.

Fossil fuels that are regarded as clean are i.a. Natural gas and Propane (LPG). Fuel cell vehicles driven by Hydrogen may be the future clean vehicle but is still not commercially available.

The policies for Clean vehicles and fuels are significantly different in different countries in Europe, which creates a barrier for large-scale use of biofuels. Neither is there a common definition of Clean Vehicles. The European Council has implemented an Alternative fuels Directive which aims to increase the use of renewable fuels in the Member States, with the objective to reach 5,75 % the year 2010. The objective is however not compulsory.

Clean Vehicles and Clean Fuels are still more expensive than ordinary. There are different policies to support the introduction of Clean Vehicles in Europe. The most successful seems to be tax relieves combined with subsidies for production of fuels and local incentives like reduced parking fee and parking lots dedicated exclusively to Clean Vehicles.

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INTRODUCTION

The fossil resources of oil, gas and coal are not unlimited. The environmental problems caused by the traffic are increasing, and traffic is now the main source for pollution like NO_x, Particles and Carbohydrates. Traffic pollution in Stockholm reduces lifetime as much as Traffic accidents do. Furthermore, fossil fuels are contributing strongly to the greenhouse effect.

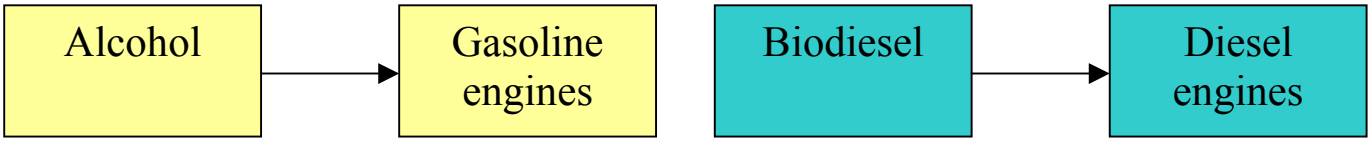
One way to reduce the problems caused by traffic is to replace ordinary Vehicles with Clean Vehicles. Such vehicles are fuelled by renewable fuels or use a technique, which dramatically reduce pollution and energy use.

I- Biofuels technologies

1-1) What are biofuels?

A biofuel is a fuel produced from vegetable or animal raw materials. It comes from the biomass in opposition to the fossil sources.

Biofuels are divided in two main sectors: alcohol (ethanol/ETBE, methanol), which serves as an additive for petrol engine, and biodiesel fuel, which serves as an additive for diesel engines. A third category is biogas, which substitutes natural gas.



Biodiesel is a fuel that is derived from vegetable oils (basically methyl esters from rapeseed or sunflower). It can entirely replace diesel or it can be mixed in different proportions. Biodiesel can be used in diesel engines without any modification. It is slightly corrosive to hoses and paints used in some vehicles, but alternatives are available at reasonable cost.

Bioethanol is the most widely used biofuel worldwide today. It is an alcohol that can be used in its pure form, as a blend with gasoline, or as a fuel for fuel cells.

Biomethanol can be produced from wood, and used in existing petrol engines in the same way as bioethanol. The production of biomethanol from wood relies on proven technology, but is not at present produced on an industrial scale anywhere in Europe.

Biocrude is a product similar to petroleum crude and can be produced from biomass using a fast pyrolysis process.

Biogas comes from the fermentation and methanation of agricultural, food industry or municipal waste. It produces methane, a gas similar to natural gas that can be used as fuel.

	Biocrude	Biodiesel	Ethanol	Biogas
Production process	Fast pyrolysis	Methanol and rapeseed esterification	Glucose fermentation and distillation	Organic waste fermentation
Raw material	Sunflower, rapeseed	Sunflower, rapeseed	Cereals, sugar-rich crops	Organic waste
Use as fuel	Pure	Pure or as additive (5 to 30%)	Pure or as additive	Natural Gas equivalent
Engine	Direct injection diesel	Diesel	Petrol or modified diesel	Petrol Diesel
Production	Small scale	Industrial	Industrial	Small scale or industrial

Fig.1. Main biofuels production

Source: ADEME

It exists several other types of biofuels; the following schema shows the different fuels existing in the world (excepting hydrogen, biogas and electricity) and their conversion routes. All the techniques and biofuels production are explained in a second paragraph.

For more explanation on biogas, see the Trendsetter report " Outlook of the biogas use in the European countries, 2003".

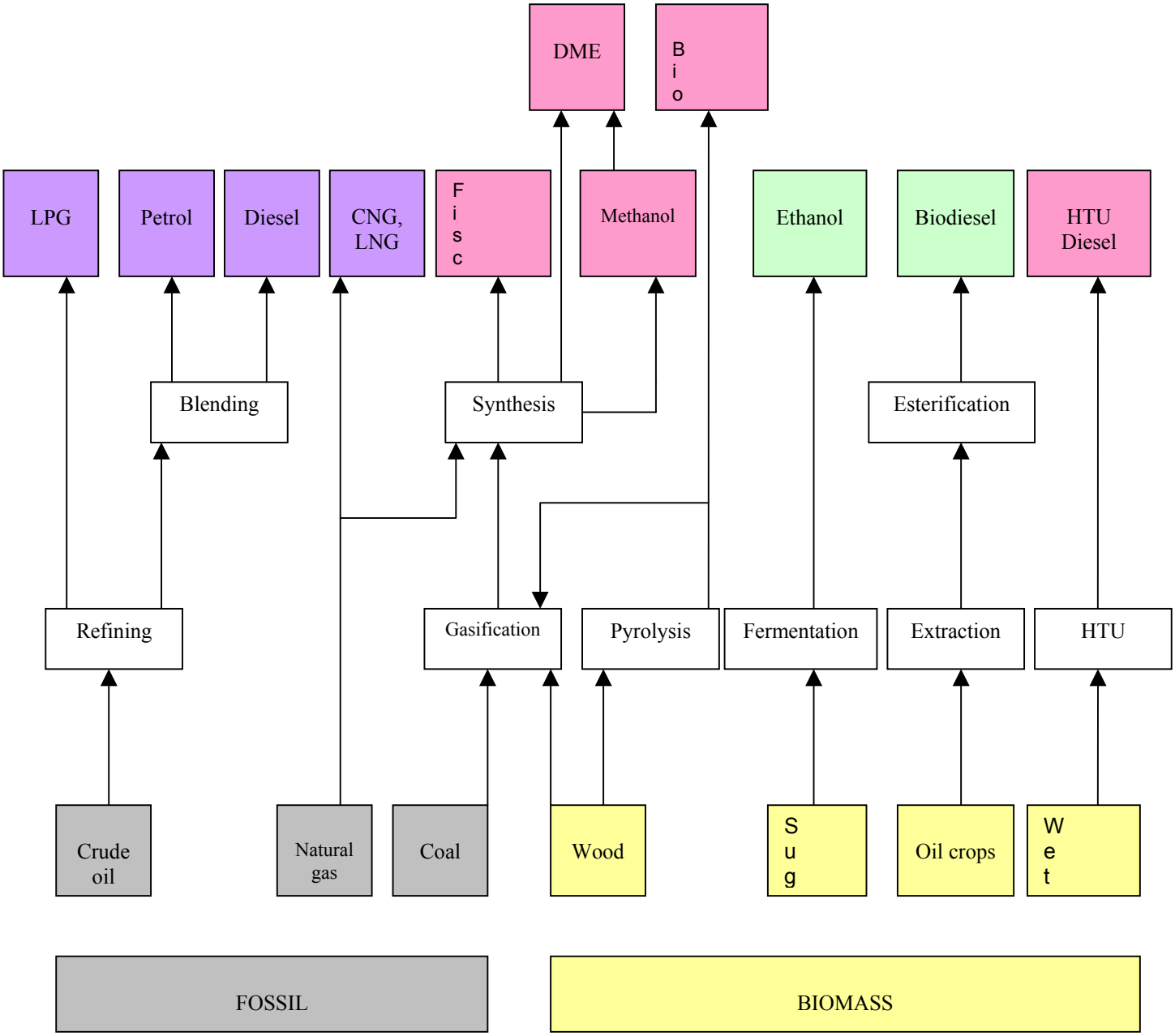


Fig.2. Overview of automotive fuel conversion routes

Source: An overview of biofuel technologies, market and policies in Europe (2003)

- **Biodiesel**

Biodiesel is produced from vegetable oils, which can be derived from oil crops. Vegetable oils have been used as fuel for a long time already. The conversion of biomass into vegetable oils for automotive fuel applications is similar to the production of vegetable oils for the food industry, which is a well-established process. Since, in Europe vegetable oils for the production of biodiesel are mainly derived from rapeseed, the biodiesel is called Rapeseed Methyl Ester (RME).

The vegetable oils that are used for biodiesel production can be extracted from the seeds or the pulp of several oil crops. The most important sources are rapeseed, soybean, palm and sunflower. For the production of 1 ton of RME, about 2,5 tons of rapeseed is needed, which requires a land area of 0,77 hectares.

- **Ethanol**

Ethanol has been used on a large scale as transportation fuel, for example in Brazil. There, 60% of the produced ethanol is sold in hydrated form (93% of ethanol and 7% of water), which completely replaces petrol in vehicle engines. The predominant technology for converting biomass to ethanol is fermentation followed by distillation. Fermentation is a bio-chemical conversion process in which the biomass is decomposed using microorganisms (bacteria or enzymes). This technology can be used for various types of biomass.

Currently, bio-ethanol is mainly produced from agricultural crops. Suitable raw materials for the production of ethanol are sugar-containing agricultural products such as sugar beet, sugar cane, molasses and sweet sorghum. A feed stock of around 3 tons of grains is needed for the production of 1 ton of ethanol.

At the present, research and development activities are mainly focused on using lignocellulosic or woody materials as a feedstock. These include short rotation energy crops, agricultural residues, forest residues, waste woods and municipal solid waste.

- **Biogas**

Biogas is a non-fossil gas, which is produced from sewage, manure, landfills or food industry waste. It is rich in methane and has the same characteristics as the natural gas

Biogas cause very low pollution to the atmosphere and since it comes from renewable energy resources, it has a great potential for future use.

For the last decade the use of biogas coming from sewage collection, farms and industrial treatment has risen constantly. Nowadays biogas plants are easily available in the market, and biogas constructions have been installed all over Europe. The upgraded biogas is mainly used for heat and electricity production. However more and more projects using biogas as vehicle fuel are set up in European cities. Indeed, this vehicle fuel is the best way to upgrade waste. Nevertheless governmental support is needed in order to make the biogas market attractive because of its high investment costs.

- **Methanol**

Like ethanol, methanol has also been used as a transportation fuel for quite a long time, especially in the USA. Methanol can be produced from synthesis gas, which results from the gasification of biomass. The methanol can also be produced from a wood origin after pyrolysis and gasification process.

- **Pyrolysis oil diesel/ Biocrude**

Pyrolysis oil is produced by conversion process called flash pyrolysis. It means that biomass is thermally converted in the absence of oxygen. With this process, a liquid is produced as an intermediate for a wide variety of applications, for example as a raw material for the production of a diesel substitute. Any type of biomass can be used for pyrolysis processes, but lignocellulosic biomass is preferred.

- **DME**

Dimethyether (DME) is currently being used mainly as a propellant in spray cans. Research on the use of DME as a transportation fuel has only started recently. A reason for this was that in the beginning of the 90´s a new method for producing DME was accidentally discovered during attempts to produce synthetic petrol from synthesis gas. Before that, DME had only been used in the cosmetics industry. It proved to be an attractive diesel substitute due to its ability to reduce the exhaust emissions of NOx. Moreover, it can be produced from different feedstocks, such as biomass and natural gas. Bio-DME is produced by means of biomass gasification followed by synthesis.

3 tons of woody materials are required for the production of 1 ton of DME.

- **Fischer-Tropsch diesel**

The Fischer-Tropsch process was initially developed in Germany in the 20´s and produced synthetic fuels in the 30´s. Originally, fossil fuels were used as a feedstock for the process. Current developments focus on producing clean Fischer-Tropsch fuels based on biomass. Like the conversion process for methanol and DME, the Fischer-Tropsch route also starts with the gasification of the biomass, which is followed by synthesis process.

Any type of biomass can be used as a feedstock, including lignocellulosic materials that come from agricultural crops, grasses, and trees. Wet biomass, like municipal solid waste and agricultural residues can be used as well but this result is a lower efficiency.

- **HTU diesel**

During the 80´s, the Shell Laboratory in Amsterdam carried research on the Hydro Thermal Upgrading process (HTU). Objectives of this process were to concentrate the energy of the biomass into an automotive fuel with a higher energy density. However, due to unfavourable economic conditions, the experiments were stopped. As bio-energy received renewed interests in the 90´s, the technology was then developed further by the Dutch company, Biofuel, founded by formers Shell employees.

1-2) Why develop biofuels?

The production of energy from biomass can reduce the fossil energy use while preserving the environment. For several years European countries have been undertaking research programmes to develop non-food outlets for agriculture products. Biofuels show the following general advantages in engines and boilers:

- Contribution to the reduction of air pollution generated by transportation and heating systems
- Contribution to the reduction of green-house gasses
- Renewable fuel
- Easy substitution of fossil fuels (no or minor modification of engines)
- Convenience of distribution (by pipe, trucks, or local supply)
- Alternative solutions for transportation, taking into consideration a new profile of partnership between rural and urban areas
- Use of additives with fuels in line with aspects of reformulation
- Support to the development of employment in rural areas.

Public concern about health effects due to urban air pollution, has became more significant in the late 1980's and early l990's, pushing European governments into the implementation of increasingly stricter legislation (on cars and fuel qualities). Recent years have seen many pressures on vehicle and fuel performance to meet increasingly stringent emissions regulations and to improve fuel consumption.

1-3) Benefits of oil substitution

- **The benefits of CO_2 avoidance on environment**

The driving force for using biodiesel and ETBE[1]/Ethanol as alternative fuel is a desire to reduce global CO_2 emissions. Thus, it is generally claimed that alternative fuels will reduce both regulated (carbon monoxide, total hydrocarbons, nitrogen oxides, particulate) and unregulated exhausts emissions (aromatic compounds, benzene), while reducing drastically sulphur emissions. Although much information have been collected on the environmental impacts of biofuels, a complete assessment of these impacts at European and international levels is still very difficult. Therefore, The European EPEFE (European Programme on Emissions, Fuels and Engines Technologies) programme, set up in 1994, was mainly aimed at establishing common European assessments of positive environmental impacts of liquid biofuels.

It is widely accepted that biofuels (from the point of crop cultivation, through to fuel produced and used) emit less harmful gases than their fossil equivalents. During the combustion cycle, it has been estimated that the most harmful greenhouse gases, besides from CO_2, are N_2O and CH_4. From biodiesel these are four to six times lower than a light vehicle running on diesel. The impact of a bus running on 30 % biodiesel mix with diesel has 25% less emission than that of a bus running on pure diesel.

On balance, the use of biofuels could play a significant role in helping to reduce the overall greenhouse gas emissions, particularly CO_2, in Europe. It has been estimated that this could be between 20-50%.

[1] Eethyl-Tertio-ButylEter (ethanol derivation)

Avoidance of CO_2 emissions from biofuel depends on the way it is produced. CO_2 emission from fossil diesel is around 3,2 tons per 1000 litres used (including emissions from production, transport). Realistic CO_2 saving for biodiesel is around 2 to 2,5 tons per 1000 litres[1]. Replacement of gasoline by ethanol is put by ADEME at 2 tons per 1000 litres. Though the use of biofuels at this moment cannot yet be justified by the benefits alone of CO_2 avoidance, it should be considered as a strategic choice for the future climate change policy.

- **Benefits for the security of supply**

The strength of the oil substitution argument is difficult to quantify but nevertheless significant. The introduction of biofuels could be expected to have a modest effect in dampening the effect of changes in crude oil prices paid by consumers. For example if the crude oil barrel price increases, blending in a certain percentage of biofuels could limit the price rise at the pump, assuming that the price of biofuels themselves are not significantly affected by the rise in crude oil prices.

- **Impact on agriculture/ employment**

The commercial use of liquid biofuels produced from renewable agricultural or forestry resources makes a positive contribution to the sustainable development of energy systems. Not only is the contribution felt in the energy sector, but also in the feedstock production sector (normally agriculture) which is under increasing pressure to diversify into alternative more profitable non-food crop production.

Increased production of raw materials for biofuels will contribute to the development of agriculture and provide a stimulus to the rural economy though the creation of new sources of income and employment.

[1] EU, http://europa.eu.int/comm/energy_transport

II- Production and use of biofuels in Europe

The main biofuels developed and used in the world are Ethanol (ETBE) and Biodiesel. The following parts will mainly deal with these fuels, the biogas production and use is treated in more detail in *Outlook of the biogas use in the European countries- Focus on the biogas used as vehicle fuel*, Trendsetter report 2003:3

2-1) Biofuel production

- **Biodiesel dominates European market**[1]

Contrary to the US, biodiesel is the dominating biofuel in Europe. France, Germany, Italy, Austria, Belgium, Denmark and Sweden together produced 1 082 000 tons of biodiesel in 2002, according to EurObserver, the EU research institute on renewable energy.

Total biodiesel production in 2002 (tons)	
France	366 000
Germany	450 000
Italy	210 000
Austria	25 000
Denmark	10 000
Belgium	20 000
Sweden	1 000
Total	**1 082 000**

Total ethanol production in 2002 (tons)	
France	96 000
Spain	100 000
Sweden	20 000
Total	**216 000**

Fig. 3. European ethanol and biodiesel production

Source: ESRU, Biofuels in Europe, European Policy, 2002 and European Biodiesel Board

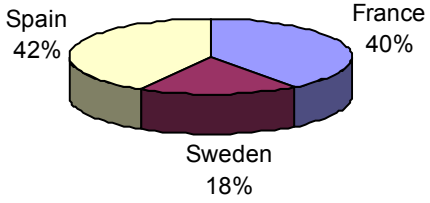


Fig.4.Ethanol production (2002)

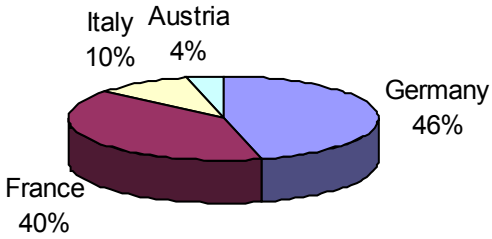


Fig.5. Biodiesel production (2002)

[1] ESRU, Biofuels in Europe, European Policy, 2002

Source: UTT Energy, Fuel trends in Europe, 2002

- **A small production of ethanol**

European ethanol production is still much smaller than biodiesel production. In 2003, France, Spain and Sweden together produced a total of 216 000 tons. Until 2002, France was the biggest European producer but does not use ethanol in its pure form. It transforms the alcohol into fuel oxygenate ETBE.

While Spain produced only 80 000 tons of ethanol in 2000, one Spanish company, Abengoa, is investing heavily in ethanol production. In 2003, Spain is becoming the first producer of ethanol in Europe, exceeding the French production.

- **A growing production of biofuels in Europe**

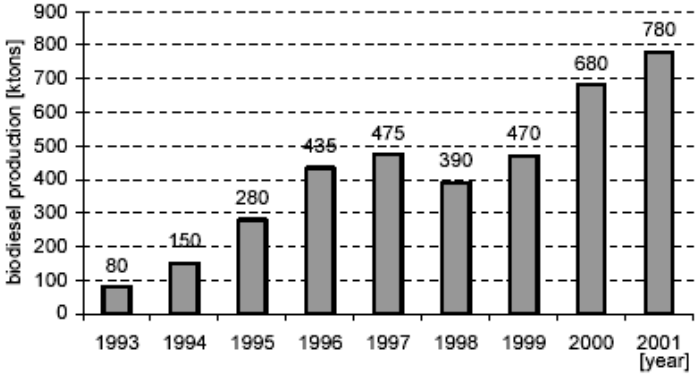


Fig.6.Evolution of the Biodiesel production in Europe

Source: UTT Energy, Fuel trends in Europe, 2000

In 10 years, the biodiesel production has been multiplied by 10 due to European promotion of the use of biofuels and agriculture growth production.

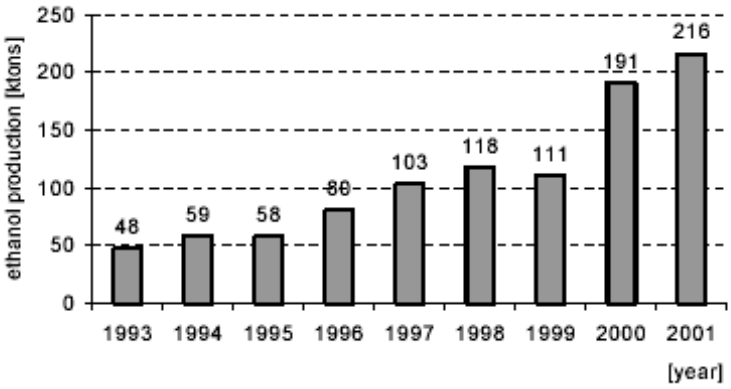


Fig.7. Evolution of the ethanol production in Europe

Source: UTT Energy, Fuel trends in Europe, 2000

In 10 years, the ethanol production has also risen but only multiplied by 5. This lower evolution compared to the biodiesel comes from the reluctance to use ethanol in the biggest producing countries (Spain, France).

2-2) Current use of biofuels in member states

The biofuels use does not require any different technologies beyond those currently used in diesel or petrol engines and which are accessible to all member states. Biofuel production basically revolves around biodiesel, with the majority of EU production concentrated in a few major companies.

	Sunflower Methyl Ester (SME)	Rape Methyl Ester (RME)	ETBE	Ethanol
Austria		X		
France	X	X	X	
Germany		X		
Greece	X			
Ireland		X		
Italy	X			
Spain	X		X	
Sweden		X		X
	BIODIESEL		**ETHANOL**	

Fig.8. Different use of biofuels in European countries

Source: According to experts and several reports[1]

The following part is extracted from a report dated from January 2003 written by the Energy Research Centre of the Netherlands[2]. It has been completed by interviews & literature studies. Even if some policy explanations are given to better understand the context of the biofuels use in the following part, the tax systems and policies will be studied in the part 3-2.

- **Austria: pure biodiesel**

[1] Eurobserv´ER, Biofuels take off expected, 2001
French Ministry, Information report on biofuels in Europe, N 2361, 2000
European Commission, Promoting biofuels and alternative fuels in transports, Action Plan, 2001

[2] E. Van Thuijl, An overview of biofuels technologies, markets and policies in Europe, January 2003

Austria has been a pioneer in establishing a bio-energy program, starting up already in 1991 one of the first biodiesel production plants in the world. In January 1999 the Austrian Government decided to improve the basic conditions for the introduction of biodiesel. A decision was therefore reached that by January 2000, fossil diesel fuel in Austria was to contain 2% biodiesel.

The Austrian Government further stimulated the development of biofuels through the alteration of its fuel excise tax system. From the 1st of January 2000 the utilisation of fuels from renewable raw materials is free of mineral oil taxes. The Austrian Law on Tax Reform 2000 exempts the use of pure biodiesel and the blending of it, if it is used as sole (bio-) fuel, provided:
- up to 5% biofuel is blended with gasoline (ethanol or ETBE)
- up to 2% biofuel is blended with diesel fuel (biodiesel)

Blends, which are less than 5%, in gasoline, or less than 2%, in diesel fuel, are taxed in the full amount. These measures have enabled Austria to produce around 30 000 tons of biodiesel per year.

Austria has a big potential to produce biogas, however this is not exploited.

- **France: the ETBE choice**[1]

France has already had a long history concerning biofuels. The country's agricultural sector is able to produce a large amount of raw material for the production of biofuels. Therefore France is currently using 70% of its non-food set-aside land (410 000 hectares) for biofuel production – both biodiesel and bioethanol. France has always been one of the dominant European producers of biofuels.

In 2001, the total French production of biofuels was about 403 000 tons. This amount comprises a biodiesel production of 312 000 tons and around 91 000 tons of ethanol production. Besides this, the country produces ETBE, a derivative of ethanol (45% of ethanol and 55% of isobutyl). In 2000, the production of ETBE amounted to 193 000 tons.

Actually, the French legislation does not authorise the use of ethanol as vehicle fuel. The advantage of using ETBE is the larger carbon chain and a better oxygenation that permits a more complete combustion.

In France, TotalFinaElf is the only producer of ETBE and RME. The oil company manufactured 200 000 tons in 2001 from plant-based ethanol, which is then added to premium gasoline. The use of RME, which cuts black smoke emissions when added to diesel fuel in sufficient quantities, increased by 25% in France in 2001.

The biodiesel produced in France mainly consists of RME and SME. Both types of biodiesel are mixed with regular diesel. SME is also used as a domestic fuel blender. Biodiesel is applied in a 30% mixture captive fleet. For regular diesel, there are blends with 5% of biodiesel.

France is the third biogas producer in Europe, though the potential as fuel is not exploited. However, Lille Metropole runs a pilot project and will operate their entire bus fleet on biogas by the year 2005.

- **Germany: a growing production of biodiesel**[1]

Germany is the main biodiesel producer in Europe; it accounts for about 30% of EU biofuel production and has rapidly expanded biodiesel production capacity over the

[1] According to G. Plassat, ADEME
[1] According to Birger Kerckow

last few years, with many additional projects planned in the future. The production of ethanol is negligible compared to that of biodiesel.

Current production is about 360 000 tons per year, but Germany is looking to increase production to around 1 million tons over the next 3–4 years.

There are about 100 refuelling stations throughout Germany where biodiesel is sold. Generally, RME is used in pure form in all kinds of vehicle in Germany. It is also one of the three countries that use 100% pure biodiesel in adapted vehicles (Austria and Sweden do the same).

Germany is the second biggest producer of biogas in Europe. However this is not used as a fuel, even though Germany has the second largest fleet of Natural Gas powered vehicles in Europe. The German Biogas Association estimates the potential for biogas and gas from biomass to be able to substitute 20 to 30 % of the actual German natural gas consumption, including gas for heating.

- **Italy**[2]

The production of biofuels in Italy mainly comprises biodiesel, namely RME and SME. With a production rate of 78 000 tons, it is the second smallest European producer. No figures for ethanol have been found for Italy.

In April 2001, the Italian authorities applied to the European Commission for an exemption from excise duty on biodiesel and other biofuels. The period was to last for duration of three years from 1 July 2001 to 30 June 2004. Exemptions from excise duty were gained for a maximum of 125 000 tons of biodiesel per year.

Biogas is not used as a fuel in Italy, in spite of the fact that Italy produces the equivalent of 143 000 tons petrol and operates some 400 000 vehicles on Natural Gas.

- **Spain, the growing country for ethanol**[3]

Spain mainly produces ethanol and ETBE. France and Spain are the only commercial producers of ETBE within the European Union. In 2001, the production rate of ethanol was almost 80 000 tons. For the year 2000, Spain produced about 170 000 tons of ETBE and 2002 the production is exceeding the French production. Spain has invested heavily in the development of its bioethanol industry and is now producing around 400 000 tons of ETBE, which is marketed on the whole of Spain.

Despite of this large ethanol production, Spain does not use ethanol as vehicle fuel. The ethanol is exported or used as chemical additive for industry.

- **Sweden**[1]

Sweden is one of the three European countries that produce ethanol. However, unlike France and Spain, Sweden is not producing ETBE. There is also a Swedish distillery using paper-mill residues as raw material. The production of ethanol has been in an experimental phase until 2001. In 2000, the production rate amounted about 20 000 tons of ethanol. In the spring of 2001, a new distillery was opened with a capacity of 40 000 tons. There is also an experimental distillery that produces Ethanol directly from cellulose. Within 3-4 years the first commercial distillery using cellulose will be operating.

[2] According to Maria Cantarella
[3] According to Eurobserv´ER, Biofuels take off expected, 2001
[1] French Ministry, Information report on biofuels in Europe, N 2361, 2001

The ethanol produced in Sweden is used in pure and blended form in automotive engines (E85 or 5% ethanol). Biodiesel is also applied on small scale; for example, pure RME in adapted fleet vehicles.

Sweden is one of the most developed European countries in the recycling and re-use of the biogas. The raw biogas comes from more than 20 sites, mainly sewage treatment plants, and it is commonly used as vehicle fuel. Half of the NGV-fleet is operated with biogas (about 1500 vehicles).

- **Netherlands**[2]

At the moment no biofuels are produced nor consumed. There are several plans for the production of biofuels. There is a plant in the vicinity of the city of Arnhem, which is aiming at producing 100 kton of biodiesel from rapeseed. The Dutch alcohol company Nedalco is also considering the production of biofuels (in this case ethanol). There are also some initiatives to adapt trucks and tractors for the use of Pure Plant Oil, but this is a smaller initiative. There is a Dutch subsidy program (GAVE-programme) which stimulates the production of climate neutral fuels, with more than 80% CO_2-reduction as in comparison to the fossil alternative. GAVE-initiatives are still in the preparation of demonstration projects.

At this moment no tax exemption is available. The ministry of environment is still considering the implementation strategy for biofuels. More information will be available at the end of this year.

Trends in biofuels in the Netherlands are that on the short term, based on the EU directive ethanol and biodiesel will enter the market, probably in blended form. The government aims at directing the long-term developments into biofuels with high CO_2 reduction potential to cope with the envisaged strong CO_2 reduction levels in order to reach low CO_2 concentrations in the atmosphere at such a level that the global warming stops.

There are about 20 landfills treatment plants existing in the Netherlands and 5 sites using bio-waste produce biogas injected into the natural gas grid. However there is no use of biogas as vehicle fuel, even if the biogas is tax exempted.

[2] According to Eric van den Heuvel

- **Belgium**

In Belgium, nearly all the production of rapeseed is done in Wallonia. The production capacity is 540 000 tons per year. Since 1995, the production of lubricants absorbs the total of rapeseed oil production and no biofuels is produced. The VITO (Vlaamse Instelling voor Technologisch Onderzoek) has carried out a 2 year biodiesel assessment project with 5 cars running on 100% RME. The biofuel is entirely produced in Flanders. The results were globally positive on the technical and emissions sides, but the cost of biodiesel is a clear bottleneck. VITO has just started a new biodiesel demonstration with 2 cars and 3 garbage trucks fuelled with a mixture of mineral diesel and UVOME (Used vegetable Oil Methyl Ester).

- **United Kingdom**

In the UK at present there is no commercial production of any biofuel. 200 tons of RME was produced by a consortium of UK companies, up until December 1995, for use in experimental field trials of alternative fuelled vehicles, but this has ceased following a change in taxation applied to the production.

Several trials have been undertaken or are currently underway in the UK. Biodiesel has been produced from rapeseed oil, which is processed into rape methyl ester (RME) now imported from Italy and Austria. The trials include examples of light duty and heavy-duty goods vehicles, passenger cars and buses. Energy use and exhaust emissions are monitored, along with the vehicle performance.

UK is the first producer of biogas of Europe. However, biogas is not used as a fuel

2-3) Biofuels in the world[1]

The EU is a major producer of biodiesel but is far from Brazil and the USA regarding the ethanol/ETBE production. The US leading position in biofuel production is not due to its competitive edge on biofuel conversion technology (which is largely a standard practice involving well-known and proven chemical processes), but because of political considerations.

- **Brazil, the biggest user of biofuels**

Brazil began its ethanol program (called Proalcohol) in 1979, in an effort to use its sugar cane crops to decrease dependence on oil imports. Since then, air quality benefits have justified continuing the effort, according to many government representatives.

Most of Brazil's vehicles are fuelled by 22% ethanol blends, and more than 4 million operate on 95% ethanol. Ten years ago, 96% of the cars sold in Brazil were made to run on ethanol.

This represents 12 thousand million litres of ethanol, or 45% of the national total fuel consumption. There are however problems with a predicted serious shortfall of production by 2015. Ethanol production has been maintained at the same level since 1988. Despite a reduction in planted sugar cane area, the agricultural productivity has increased per hectare. However since 1989, the indigenous ethanol supply has been insufficient to meet domestic demand. The supply problems are due to controversy over the ethanol production costs (production costs are higher than the government stipulated selling prices), coupled with the fact that the production plants are attracted to the high world prices for refined sugar. The total stock of cars and light vehicles is forecast to increase from 12 million to 14 million by 2000, and to 29 million by 2015. Brazil is the only country that is producing a major amount of ethanol and the only real competitor to the USA.

- **USA developed the ethanol sector**

In the USA nearly 3.7 million litres of ethanol is produced, this represents about 1% of the total motor fuels consumption in the USA per annum. It is primarily produced from corn and is blended at a 10% concentration with petrol. Ethanol benefits from fiscal advantages at both the state and federal government levels. The current market for ethanol exists only because a gallon of ethanol is taxed at a lower rate than a gallon of gasoline at the federal level and in some states. This exemption brings the cost of pure ethanol, which is higher than that of conventional gasoline and other oxygenates, within reach of the cost of competitive substances. In addition, there are other incentives such as a small ethanol producers tax credit.

For example, the Minnesota mandates that only ethanol blends be sold instead of pure gasoline and is considering a similar mandate for biodiesel. In the Midwest, Environmental Protection Agency summer air pollution reduction mandates are achieved through use of ethanol. Vermont has explicitly included farming operations in its net metering rules, thus removing a key barrier to the use of biomass for generation of electricity.

[1] Soybean Digest, US versus the world: in EU biodiesel king, in Brazil ethanol rules, 2002
Group on Grain and Oilseed, Biofuels: situation and outlook, 2002

Country	Ethanol (Ktons)
Brazil	13 000
USA	4 000
Canada	200
Europe	216
Spain	*100*
France	*96*
Sweden	*20*

Fig.9. Biggest producers of ethanol in 2002

Source: Group on Grain and Oilseed, Biofuels: situation and outlook, 2002

- **Comparison between Europe and America**

Country	Ethanol use in engines	Regulations	Ethanol consumption (Millions hectolitres)	Biodiesel Consumption (Millions hectolitres)
USA	10 % blend E85	Tax exemption	67	Programs under way
Canada	5-10 % blend	Tax exemption	2,5	0,01
Brazil	Pure or 24 % blend	Tax exemption	120	
Europe	Ethanol 5 % blend or ETBE 15 % blend E85	See part III-3. No common regulation.	3	12

Fig.10. Taxation and consumption comparison

Source: Group on Grain and Oilseed, *Biofuels: situation and outlook*, 2002

The large amount of production and the possibility of setting up tax exemptions for biofuels mainly come from the large size of countries. Indeed Brazil and USA have a wise production potential that permits a lower production cost and a bigger market (due to the population size).

2-4) Producers of biofuels

There are few producers and distributors of biofuels in Europe. The biggest producer of ethanol comes from USA and makes some investments in the European biofuels production. The market is divided into three kinds of producers:

- individual farmers that often create co-operatives
- large biofuel plants
- Fossil Oil companies

Country	**Company**	**Biofuel**	**Address**
USA	Archer Daniels Midland	Ethanol	www.admworld.com
Spain	Abengoa Biocombustibles Vascos	Ethanol Biodiesel	www.abengoa.com
France	TotalElfFina	ETBE and Biodiesel	www.totalfinaelf.com
Sweden	Ekobränsle Romaetanol Agroetanol Sekab	Biodiesel Ethanol Ethanol Ethanol	www.ecobransle.se www.romaetanol.se www.agroetanol.se www.sekab.se
Austria	Ölmühle	Biodiesel	www.oelmuhele-solling.de
Netherland	OPEK Nedalco	Biodiesel Ethanol	www.opek.nl www.nedalco.com

s			
I t a l y	Bakelite Novaol	Biodiesel Biodiesel	www.bakelite.de www.novaol.it

Fig.11. Main biofuel producers

Knowing the strategy and future developments of those biofuel producers could have been a very interesting point. Unfortunately it was impossible to have the point of view of the biggest producers.

III- Policies, taxes, barriers and critical success factors for the biofuel development

3-1) Policies and Taxes for the biofuels: EU directives

The development of renewable energies, in particular biofuels, is a clear political priority for the EU in the context of greenhouse gases reduction. Security of the EU energy supply is also becoming of increasing importance.

Tax incentives are an effective tool of both environmental and energy policy. Taxes make up a significant proportion of the selling price of energy products, in particular motor and heating fuels. Appropriate differentiation of excise rates would contribute to the development of the biofuel industry by offsetting the high cost of manufacturing biofuels compared to fossil fuels.

Energy products are basically taxed in three ways:

- excise duties, which are specific duties (proportional to the physical quantity of the product),
- dedicated taxes and duties, and
- VAT (proportional to the selling price of the product).

Currently, there is neither Community framework for energy products other than mineral oils nor for taxes than excise duty and VAT.

The " Communication from the Commission on alternative fuels for road transportation and on a set of measures to promote the use of biofuels" includes two proposals. The first aims at promoting the use of biofuels for transport by setting biofuel sale targets for the EU member's states. This has been adopted in May 2003 [Directive 2003/30/CE].

The second proposal, amending the Directive 92/81/EEC allows the member states to apply a reduced rate of excise duty on a certain mineral oils containing biofuels and on biofuels. Pursuant to the Directive 92/81/EEC, biofuels blended into engines or heating fuel are taxed according to end product and use. This has not yet been implemented.

Directive 2003/30/EC On The Promotion Of The Use Of Biofuels Or Other Renewable Fuels For Transport, adopted in May 2003, fixes the following objectives:

	BIOFUELS and alternative fuels*
2005	**2%**
2010	**5,75%**

* fuels that come from renewable energy

Fig.12 Incentives of the renewable part of the vehicles fleet in Europe

Source: European Commission, Directive 2003/30/EC

1) OBJECTIVE

To create a Community framework that will promote the use of biofuels in order to reduce greenhouse gas emissions and the environmental impact of transport, and to increase security of supply.

2) CONTENTS

1. The directive sets a minimum percentage of biofuels to replace diesel or petrol for transport purposes in each Member State. It is a question of reducing conventional emissions of CO2 (carbon dioxide), CO (carbon monoxide), NOx (nitrogen oxides), VOC (volatile organic compounds) and other particles which are toxic for health and the environment.

2. The different types of biofuels are as follows:
   - bioethanol: produced from biomass;
   - biodiesel: a methyl-ester produced from vegetable or animal oil
   - biogas: a fuel gas produced from biomass…, that can be purified to natural gas quality;
   - biomethanol: methanol produced from biomass;
   - biodimethylether: dimethylether produced from biomass;
   - ETBE: etherized bioethanol;
   - MTBE: a fuel produced on the basis of biomethanol bio-oil: bio-dimethylether
   - synthetic biofuels produced from biomass:
   - biohydrogen: hydrogen produced from biomass
   - pure vegetable oil

3. Each Member states will fix the incentives concerning the biofuels part on the market. Those incentives must be based on the Directive (2% fuel replacement for December 2005 and 5,75% for December 2010). Countries that fix lower incentives will have to justify with objective criteria their decision.
   The governments must announce before July 2004 the incentives they want to reach.

4. The biofuels can be made available as:
   - pure biofuels;
   - blended biofuels;
   - liquids derived from biofuels.

5. The Commission will present a report to the European Parliament and to the Council before 31st December 2006 on the progress achieved in the use of biofuels in the Member States.

3-2) Current national policies for the promotion of biofuels

As the European countries are free to interpret and apply the EU Directive (92/81/EEC), we will study every national policy concerning biofuels.

- **France**

Liquid biofuels is one of the four bio-energies in France. The national program for biofuels comprises a 100% tax exemption for biodiesel production and an 80% tax exemption for ethanol production. This is in conformance with the "biofuel production program" administrated by the Energy and Environment Agency (ADEME[1]). This mechanism of fiscal incentive aims at developing investments for biofuel production but a limit has now been imposed, due to the European legislation. (Following the principle of equitable competition between different countries in the EU).

- **Germany**

Germany is one of the six member states that produce biofuels on a commercial basis. The law on the Excise Tax and Oil Products regulates national policy on biofuels.

Alcohol and vegetable oil fuels are not mineral oils so they don't fall within the scope of this law.

- **Spain**

In Spain policy for biofuels can be divided into national and regional policies. On a national level few regulation is found for a country that is producing biofuels on a commercial basis. There is a fiscal measure that guarantees a state discount for investments made in new tangible fixed assets that are intended for the use of renewable energy sources. The discount is 10 % of the investment made. The treatment of agricultural materials, forestry or oils used for its transformation into biofuels is one of the investments qualified for this reduction.

The development of biofuels is also influenced by the Royal Decree 1165/95 for the application of financial exemption. This decree ensures a reduced rate of excise duty.

Finally, discounts and loans are delivered for biofuels projects: the subsidy rate of the project has been fixed by the government at 30 % of the costs.

- **Italy**

Since 1991 biodiesel was distributed to municipalities, individual transport firms and the local municipal departments. Italy is one of the four countries that are authorised for a certain level of annual biodiesel production by the EU. The quota is about 125 000 tons. Furthermore, EU also allowed Italy to reduce excise duties on fuels containing biodiesel until the end of June 2004. The proposal applied to mixture containing 5% or 25% of biodiesel.

	Biodiesel 5%	Biodiesel 25%	Diesel
Excise duty in €/ 1000 litres	362,6	286,3	381,7

Besides the policy incentives for biodiesel, there is legislation for ethanol and ETBE as well.

[1] ADEME : French Agency of Energy and Environment

- **Sweden**

The Swedish government has a policy, which aims at the reduction of the use of fossil fuels and the promotion of the use of renewable energy sources such as biofuels. This is done by taxation and administrative measures. The most important policy measures for biofuels in Sweden are that biofuels are exempt from energy taxes, environmental taxes and fees. Biofuels are exempt from three concrete measures: these are the Carbon Dioxide Tax, the Sulphur Tax and the Energy Tax.

Besides this direct energy taxation, the production and use of biofuels is promoted in an indirect way by so called green taxes. For example, the carbon dioxide tax has resulted in an increased use of biofuels. These fiscal measures seem to have a very positive effect on the production and use of biofuels. But it should also mention that this implies mainly the use of biofuels in the district-heating sector, and not specifically in the transport sector.

- **Austria**

Austria is one of the four European countries that produce biodiesel. A new policy focuses on renewable materials, which led to an increase in the production of these materials. For example contributions are paid to farmers that use fallow land for growing renewable energy.

Besides this policy that supports the production of vegetable, the Austrian government also aims at supporting the production of biofuels by taxes reductions.

Biodiesel in **pure form**	Biofuel in a blend **>5%**	Biofuel in a blend **<5%**
100% tax exemption	Exemption of the entire biofuel share	No tax exemption

However, ethanol is not defined as a biofuel in this legislation and obtains hence no tax reduction.

- **Other European countries**

Belgium

Biofuels are not defined clearly, and there is no existing biofuel policy. However, fuels other than mineral oil products are excluded from the levy tax.

Denmark

The Danish government does not have any biofuel specific policy. Biofuels are imposed to the Danish CO_2, SO_2 and energy tax.

Finland

As Finland is not producing biofuels on a commercial basis, there is no legislation scheme for them.

Greece

Greece is not very active in the field of biofuels. There is no legislation concerning biofuels.

Ireland

Ireland has not developed a biofuel production. However, the Irish government has introduced a legislation in order to reduce excise duty on the use of biofuels. But it has never been applied.

The Netherlands

The taxation situation is rather complex with a road tax for all vehicles and a special tax only applicable for passenger cars and motorbikes.

- Road tax is a very complex system, in short:
  Free from tax are electric and hydrogen vehicles (to some extent also hybrids, depending on the sort of hybrid)
  Petrol is cheapest, followed by NG and G3 gas. Diesel and other gases (like LPG) are the most expensive.
- Special tax for passenger cars and motorbikes (BPM):
  Free from tax are at this moment only electric and hydrogen vehicles

In 2001 two motions were proposed to promote the use of biofuels in engines. The first motion requests the government to propose a complete tax exemption for cold pressed vegetable oils as a long-term experiment in diesel engines of cruises, agricultural vehicles and road vehicles. The second motion requested the government to propose a tax exemption for refined biofuels. So far nothing has yet been adopted.

Portugal

No policy, except a tax reduction on biofuels used for pilot projects.

United Kingdom

The UK has implemented policy for biofuels relatively recently. The goal of the British government is to reduce CO_2 emissions and to improve air quality. The support results in the legislative measure called the Green Fuel Challenge, which can be considered as a framework for commissioning innovative bids for green fuels. A duty reduction was announced of 20 pence per litre, which is 20 pence below the duty rate of Ultra Low Sulphur Diesel. This will balance the additional production costs of biodiesel.

3-3) Table of the National policies

Country	VAT	Excise duty	Biofuel Legislation		
			None	Development	Existing
Spain	16%	Reduced rate			Discount for investments
France	19,6%	• 100% tax exemption biodiesel • 80% tax exemption ethanol			Fiscal incentives
Sweden	25%	No energy tax No environmental tax			Fiscal measures
Germany	16%		X		
Austria	10%	Tax reduction/exemption			Contributions for farmers
UK	5%	Duty reduction		X	
Belgium	6%	No levy tax	X		
Greece			X		
Finland			X		
Portugal		Tax reduction for pilot projects	X		
Italy	20%	Reduced rate			Fiscal incentives
Denmark	22%		X		
Netherlands		Tax exemption		X	

Fig.13. Biofuels policies in Europe

Source: BioMat Net, ALTNER, NTB Liquid biofuels Network and European Commission, La taxation des voitures particulières dans la Communauté Européenne, N 431, 2002

3-4) Barriers to the development of biofuels and critical success factors

- **Biodiesel still expensive**

Biodiesel is more expensive than petroleum diesel. Biodiesel has a production cost of approximately 500 €/1000 litres, compared with 200-250€ /1000 litres for traditional petroleum-based diesel, including the refinery cost.
Currently, Germany, Austria and Sweden use 100% pure biodiesel in adapted vehicles. In France, biodiesel is blended at 30% in captive fleets and also used in blends of 5% in normal diesel fuel. In Italy, it is blended at 5% in normal diesel fuel.

Petroleum based Diesel	Biodiesel
200/250 € per 1000 litres	500 € per 1000 litres

In view of the fact that it takes 1100 litres of biodiesel to replace 1000 litres of petroleum based product, the economic calculation[1] shows an additional cost of at least 300 €/1000 litres of diesel replaced by biodiesel.

- **Ethanol is not supported by the Oil producers**

Nowadays, the diesel market is in loss of speed, so the big Oil Consortium acts in favour of the biodiesel. Actually this biofuel cannot affect the diesel sector. On the opposite way, the petrol market is still prosperous; replacing petrol by ethanol could affect the petrol market.

Even if the production cost is slightly lower for ethanol than for the biodiesel, it takes 1,25 litres of ethanol to replace 1 litre of petrol. This point makes the replacement price of the petrol by the ethanol more expensive.

- **Financial incentives and tax system policies**

The fragmentation of fuel tax systems in Europe, with different countries adopting specific tax exemptions on different fuel specifications, creates a barrier to the development of the sector and of European trade.

In order to be able to compete with fossil fuels routes, renewable energies routes and possibly liquid biofuels should be financially supported, through a tax relief policy or though direct aid granted to the channel (direct support to farmers, industries; tax relief on green energy). If duty were at the same rate as that levied on petrol or diesel, biofuels would be far too expensive to hold a competitive place. For example, in France, tax relieves are applied on biofuels, but only for the plants that have official agreements. The implementation of a carbon tax would clearly favour the development of biofuels.

Even by achieving the full potential for biofuel use, it would account for a small share of the automotive fuel market and maintaining the exemption from special taxes in respect of biofuels will not lead to a large drop in tax income. However, a progressive application of taxes on biofuels is being considered, once the market is fully developed. The drop in tax income as a result of total or partial tax exemption would be offset by the increase in economic activity in the production field.

[1] EAV, World biofuels, 2002

Considering the future development of ETBE and methyl ester in Europe, it would appear that in the short and medium term, tax relief is the most effective way to ensure that biofuels are competitive. This already applies without any problem to other fossil fuel (GPL) and to other forms of energy used in transport (electricity). To adopt tax legislation at Community level, the member states will have to be unanimous, and at present this appears to be unlikely.

- **Lack of information**

Potential users of biofuels will need more information than is currently available about the performance of the fuel to install confidence in the product. In fact, even if all the car users presently buy biofuels without knowing it (there is no obligation to mention the rate of biofuels at the pump), they still do not know what biofuels are.

At the agricultural stage of biofuel production more information is needed to encourage the cultivation of non-food crops. Greater simplification and more information is needed at the procedural level and in terms of the statements required to produce this type of crop for non-food uses.

- **Financial and infrastructure**[3]

The investment in installations in the production process is small, so financing is not a major problem. Substantial investment is however required to produce ethanol, because of the large production capacity needed to supply refineries for transformation to ETBE. But generally, financing of biofuels transformation faces the same financing criteria as any other plant investment. Without proven markets such plant will therefore be difficult to finance.

Production plant and a guaranteed supply of agricultural raw materials are essential for a widespread use of biofuel, but there is a lack of guaranteed supply of agricultural EU raw materials at competitive prices (compared to non-EU production). For ethanol ex-sugar beet, the limitation is due to the actual production capacities (too expensive to increase in comparison with the development of plant for wheat). In some cases, like in the Netherlands, there is not enough land available for the national production of non-food crops.

- **Price distortions**[1]

Past experience (for instance, in the UK or Belgium) has shown that the fuel pump price differential is an effective method to increase the market share of a particular fuel. Thus, with the production costs of biofuel, currently far higher than conventional fuels, it will be very difficult to gain market share without a subsidies or favourable duty and taxation levels. No market opening can be expected as long as tax relieves for liquid biofuels is not a European obligation.

- **Critical success factors**

Action aimed at reducing the price of the end product in the sectors involved in the biofuel production process (agricultural, the oil or ethanol extraction industry and the transesterification industry), will depend on the authorities with powers in each sector. It is more likely to succeed if they are taken by all parties involved and in a co-ordinated manner.

[3] http://europa.eu.int/comm/energy_transport/atlas/html/biooverview.html

EU directives ensure that member states must permit petrol containing specified low percentages of organic oxygenates, such as methanol and ethanol, to be sold without the need for special markings. Today, Member states are permitted to forbid the sale of gasoline with more than these specified low percentages of organic oxygenates.

Since the properties of biodiesel differ little from those of mineral diesel there would be no regulatory barriers to its use.

Main critical factors for market deployment of biofuels are:

- Price of agricultural non-food product and creation of new markets.
- Availability of land for production of industrial crops, and competing demands for use of such land.
- Tax relief for biofuels.
- Clear political involvement in a long-term horizon.
- Promotional experiments carried out at local, regional and national levels.

IV- Clean vehicles in Europe

4-1) What is a clean vehicle?

The transportation sector is the origin of a large amount of pollutant emissions, which have a direct influence on several environmental receptors (inhabitants, agriculture, ecosystem, etc.)

This pollution can be found on different levels:

- on the urban scale: carbon monoxides emissions, volatile organic components, hydrocarbon emissions, and particulate.
- on the local and regional scale: secondary particulate (nitrates, phosphates), acid rains, photochemical pollution
- on a global scale: global warming

The damage caused on the environment by the transports is very sensitive in the urban areas. This is the result of the simultaneous presence of a large amount of polluting sources and numerous receptors (inhabitants, buildings).
Studies completed in the European project ExternE framework showed that the local impacts are the biggest damages caused by atmospheric pollution. These studies focus on the high prices represented by the transportation pollution. In this context, the introduction of clean vehicles seams to be an interesting solution to contribute efficiently to the reduction of pollutant emissions in the city, in a sustainable development of the transports.

The definition of a clean vehicle differs according to the European countries. For some of them, the vehicle must complete strict tests, for others the fuel should come from renewable origin. For the majority of countries the definition of a clean vehicle is:

" *Some vehicle fuels, because of physical or chemical properties, create less pollution than do today's gasoline. These are called "clean fuels." The vehicles that use those clean fuels are clean vehicles.*"[1]

[1] Université Libre de Bruxelles, Véhicules propres, 2002

4-2) The different categories of clean vehicles

Clean vehicles in production and on the road are today capable of easily reaching the top speeds of conventional vehicles, with fast acceleration and quick response. In addition to features comparable to petrol-powered vehicles, clean vehicles have many unique characteristics, including low vehicle weight, superior aerodynamics and a smooth, quiet ride

The different types of fuels are not sufficient to determine if a vehicle is clean or not. Indeed, even if the fuel permits to calculate the pollutant emission rates, the technology of the vehicle also classifies its clean characteristics.

The fuels considered as clean fuels are (there are some differences depending on countries - see IV-3):

- Ethanol, ETBE
- Biodiesel
- Biogas
- Electricity
- Hybrid Engines
- Hydrogen (Fuel cells or liquid Hydrogen)[4]
- Natural Gas (Compressed/Liquid)
- Propane (Liquid Petroleum Gas, LPG)
- Reformulated fuels

Though fuelled by fossil fuels, ALSO regarded as clean are
- Low emission vehicles

ETHANOL, BIODIESEL, BIOGAS
See previous part I

ELECTRICITY

There are two types of electric in-source vehicles, pure electric and hybrid. In the pure electric vehicle, the drive power required is solely obtained from a set of batteries. This restricts the range of the vehicle because the batteries need to be recharged from the grid.

Electricity can be used as a transportation fuel to power battery electric and fuel cell vehicles. When used to power electric vehicles or EVs, electricity is stored in an energy storage device such as a battery. EV batteries have a limited storage capacity and their electricity must be replenished by plugging the vehicle into an electrical source. The electricity for recharging the batteries can come from the existing power grid or from distributed renewable sources such as solar or wind energy.

[4] Hydrogen is normally regarded as an energy carrier. In this context it will be treated as a clean fuel

Battery-powered vehicles give off virtually no pollution and offer one of the best options for reducing motor vehicle emissions in polluted cities. Power plants that produce electricity do pollute. But these plants are often in rural areas where the emissions do not drive pollution levels above health standards. Also, efficient emission controls can be installed and maintained more easily on individual power plants than on millions of vehicles. The driving range of today's electric cars is limited by the amount of power the battery can provide. Current batteries take 20 minutes to hours to recharge and the cost of electric vehicles is high. Recent developments in electric vehicle technology show much promise for the future.

HYBRID

There are two types of hybrid vehicle, parallel and series. In the parallel hybrid, electricity is obtained from a small Diesel generator set with an optimised constant turning system and power that allows the vehicle to travel at low speed. Additional power needed for acceleration and start-off is provided by a set of batteries which are recharged while braking and when the vehicle is stationary. In the series hybrid concept, there are two drive systems, electric and mechanical heat, which can be separated or coupled in a single kinematics chain. When the electric drive is used, energy is obtained from a set of batteries, which is partly recharged when travelling under mechanical drive and by using braking energy.

HYDROGEN

Hydrogen is a gaseous fuel; it can be obtained from electrolysis of water, or through a reformer process (on board a vehicle) from methanol or gasoline for use in fuel cells[1].

Hydrogen gas (H_2) will play an important role in developing sustainable transportation, because it can be produced in virtually unlimited quantities using renewable resources. Pure hydrogen and hydrogen mixed with natural gas (hythane) have been used effectively to power automobiles. However, hydrogen's real potential rests in its future role as fuel for fuel cell vehicles.

Hydrogen gas (H_2) is being explored for use in combustion engines and fuel-cell electric vehicles. It is a gas at normal temperatures and pressures, which presents greater transportation and storage hurdles than exist for the liquid fuels. Storage systems being developed include compressed hydrogen, liquid hydrogen, and chemical bonding between hydrogen and a storage material (for example, metal hydrides).

While no transportation distribution system currently exists, for hydrogen transportation use, the ability to create the fuel from a variety of resources and its clean-burning properties make it a desirable alternative fuel.

It also exists a new technology that produces liquid hydrogen and uses it as liquid fuel.

NATURAL GAS

[1]A fuel cell is an electrochemical device that converts, without open combustion; the energy bound in a liquid or gaseous fuel directly into electricity at relatively high efficiency levels (up to about 60%). In state-of-the-art fuel cells hydrogen stored in high-pressure tanks is used to react chemically with oxygen from the surrounding air to form water. Part of the energy from this reaction is collected in the form of electric charges through proton exchange, the other part (about 40%) is waste heat. A fuel cell operating on pure hydrogen produces virtually no emissions (only water and heat).

Natural gas is abundant and is widely used for home heating and industrial processes. It is easily transported through pipelines and costs about the same or slightly less than gasoline.

There are significant tradeoffs for CNG vehicles for emissions, vehicle power, efficiency, and range. Natural gas is already used in some fleet vehicles and appears to have a future as a motor vehicle fuel. Though emitting lower levels of toxic and ozone-forming hydrocarbons than petrol, it is a fossil fuel and contributes to green-house effect

LPG

Liquid petroleum gas (LPG) is a mixture of butane and propane in different proportions obtained as a by-product of oil refining. It burns cleaner than gasoline but is limited in supply. Propane-fuelled vehicles are already common in many parts of the world.

Since LPG has a high octane rating, LPG engines can be designed with a high compression ratio, which is more efficient than conventional petrol engines, although they have a poorer performance compared with diesel engines (approximately 20%) due to the difference in cycle efficiency.

There are engine designs to enable bi-fuelling - allowing a conventional fuel or LPG to be used within the same vehicle. Such designs require doubling of fuel storage capacity, retaining original fuel tanks with the addition of LPG storage. In private cars, such systems significantly reduce other storage space, although in buses, for example, this is less of an issue.

REFORMULATED AND OXYGENATED GASOLINE

The petroleum industry is beginning to market gasoline formulations that emit less hydrocarbons, nitrogen oxides, carbon monoxide, and toxins than conventional gasoline. These new fuels can be introduced without major modification to existing vehicles or the fuel distribution system.

- **Comparative analysis of the clean fuels characteristics**

Source: Uppenberg.S. et.al.2001, Miljöfaktabok för bränslen

	Petrol[5]	Diesel	LPG	NG	Biodiesel	Ethanol	Biogas	Electricity[6]		Fuel Cell	Hybrid
State of art[7]	+++	+++	++	+	-	-	-	-		---	+
NOx	100%	412%	81%	71%	544%	67%	68%	15-40%	0 %	3%	25-40%
VOC	100%	78%	71%	30%	75%	32%	20%[8]	1-20%	0 %	1%	10-50%
CO	100%	89%	21%	19%	100%	100%[9]	20%	0-1%	0 %	1%	10%
SO_2	100%	63%	53%	11%	60%	10%	14%	200%	0 %	1%	
Total CO_2	100%	99%	86%	71%	11%	18%	4%	80%	0 %	2%	60%
PM	100%	578%	62%	47%	511%	44%	78%	70%	0 %		5%
energy consumption	100%	70-90%	90%	110%	85%	110%	20%	25-30%		Depending on fuel	
Autonomy	500km	600km	300km	200-250km	400km	350km	200-250km	70-100km		600km	> 600km
Fuelling time	Few minutes	Few minutes	Few minutes	10min	Few minutes	Few minutes	10min	15minutes		Depending on fuel	
Safety	Carcinogenic flammable	Noxious Carcinogenic	Carcinogenic flammable	Carcinogenic inflammable	biodegradable	Noxious, corrosive	Inflammable carcinogenic	Recyclable battery		Depending on fuel	
Infrastructure[10]	+++	+++	+++	-	+	-	--	--		Depending on fuel	

[5] Petrol used as reference for emissions and energy consumption
[6] 0 % if renewable source
[7] number of vehicles, information, technology of the vehicles: well developed (+++) to pilot project (---)
[8] Magnus Blinge, 2003
[9] With catalytic converter
[10] fuelling stations, distribution, production plant]: well-developed (+++) to pilot projects (---)

JUSTIFICATIONS TO THE TABLE

State of art:

The alternative technology that is the most available is the LPG. Even if some manufactures propose natural gas vehicles, the infrastructure is still under-developed (fuelling stations, supply). At a long-term view, the fuel cells shall replace the batteries of the electric vehicles. The hybrid vehicles have a good potential but they are not enough developed (information, price).

Environmental performances:

The reference is a gasoline vehicle; compared to that the diesel vehicle produce more emissions in general. The gasoline has got here 100% pollutant emissions, and the other fuels are compared to its performances. The results are an average of a Belgium study done with strict tests of measurements.

For the new LPG vehicles, the emissions will be lower than for conventional ones. Concerning the natural gas, only volatile emissions (methane) can be higher than gasoline vehicles. Natural gas and LPG produce CO_2 emissions lower or at the same level than the diesel ones. Biogas vehicles have the same characteristics as the natural gas, except lower emissions rates for CO and CO_2. Indeed, the production of biogas does not produce extra carbon dioxide because of its renewable origin.

For the biodiesel vehicles, the majority of the emissions are produced on the production phase (agriculture, oil extraction, esterification).

Ethanol produces a very low level of emissions, except for the CO_2 extracted from the alcohol transformation. However, this CO_2 is non-fossil and does not add to the greenhouse effects.

The principal interest of the electric vehicles is the low or zero emission rates. The electricity production technology is determinant for the emission calculation: from renewable energy, the emissions are non-existent. The emissions coming from hybrid vehicles are linked to the fuel used.

Energy consumption:

The direct energy consumption deals with the fuel consumption. The indirect energy consumption takes account of the production and distribution of the fuel.

The diesel and LPG vehicles use less fuel than the gasoline ones. Biodiesel and ethanol engines have appreciatively the same energy consumption rate. An electric engine has a better output than a normal one, so the energy consumption is lower.

Autonomy:

LPG and NG vehicles have a lower autonomy than the conventional vehicles. Electrical vehicles have a battery that cannot overpass 100km of autonomy. The fuel cells vehicles have an independence of 600 km (in most cases) and the hybrid vehicles have a better autonomy than petrol ones because of their high output of the cinematic chain.

- **Fossil fuelled Vehicles regarded as clean**

Low fuel consumption vehicles

On the fuel consumption front, substantial successes have been achieved in recent years and innovative developments and technologies promise to bring further improvements in the future. The advances are partly due to state-of-the-art, fuel-efficient engine design, as well as to sophisticated aerodynamics and lightweight design. Today, more and more models incorporate a lightweight design concept, while new transmission concepts provide a further means of improving fuel economy (Example: the new S-Class sedans are on average 210 kilograms lighter than the previous models, and fuel consumption has been cut by between 13 and 22 percent, depending on engine).

In several European countries, auto manufacturers have agreed to voluntary commitments to improve fuel consumption on a national level, because national markets in Europe are still not homogenous, mainly driven by different taxation schemes.
The German manufacturer association (VDA) has been monitoring fuel consumption of the sales weighted new vehicles since 1978. Compared to 1978 levels, Opel has improved sales weighted fuel consumption of its fleet by more than 34%.

YEAR	*REDUCTION*
1978	0.0%
1979	-2.0%
1980	-5.4%
1981	-11.1%
1982	-13.6%
1983	-16.8%
1984	-20.5%
1985	-22.7%
1986	-23.6%
1987	-21.2%
1988	-19.3%
1989	-18.6%
1990	-18.6%
1991	-19.8%
1992	-21.3%
1993	-21.9%
1994	-23.7%
1995	-23.9%
1996	-25.1%
1997	-25.5%
1998	-27.9%
1999	-31.4%
2000	-33.1%
2001	-34.3%

Fig.14. Opel weight cars evolution

Source:AFDC, afdc.doe.gov/afve

Catalytic converters

Today, the control of the engine exhaust gas and mufflers is getting stronger. There are two classes of catalytic converters:
- the oxidation converter
- the three ways converter

In the first technology, the carbon monoxide and the hydrocarbons are transformed into CO_2 and water. The advantage of this muffler is its selective way to reduce the most noxious components that are emitted by the engine.

In the second technology, the hydrocarbons, carbon monoxide and NOx are treated simultaneously. Unfortunately, this system can not be adapted to a diesel engine.

Engine technology

In order to complete strict imposed norms about exhaust emissions, the engine technology is in perpetual changes. The use of electronic and microprocessors in order to control the fuel injection and the exhausted gas is more and more common.

For example, in gasoline engines, the Multi Point Injection shall be replaced by the direct injection. Indeed the direct injection motors obtain a best control of the combustion and of the injected quantities of fuel. By the way, the exhaust gases are better controlled.

Moreover, the engines would become smaller with a best output: the fuel consumption would slow down.

All those new technologies permit to control the exhaust gas and to decrease the pollutant emissions. But a combination between a relevant technology and a clean fuel is the best choice in order to decrease the atmospheric pollution.

4-3) *What is considered as a clean vehicle in Europe?*

As the definition of a clean vehicle differs from each country, the best method to compare the spread of clean vehicles is to sort the different vehicle categories in a table.

Those data were very difficult to collect, actually it is common that the national authorities, the energy and environment authorities and the clean fuel associations have different point of view about the clean vehicles definitions. It is the reason why this table must be considered as a "trend-table"; the data could change according to new legislation or different sources.

However, it appears that biogas, biodiesel, electric, hybrid and fuel cell-vehicles are considered as clean. Reformulated fuels, filters and Euro 2005 vehicles are not considered as clean ones. Ethanol, LPG and Natural Gas are in an intermediate class in Europe (no clear demarcation); the low consumption vehicles are not common enough to have a clear definition.

	Fossil fuel with filter	LPG	NG	Biogas	El.	Ethanol	Biodiesel	Hybrid/ Fuel cell	Low cons. fuel	Reformulated fossil fuels	Euro 2005 Fossil fuel
Germany[1]	-	-	-	+	+	+	+	+	*	+	-
France[2]	-	*	+	+	+	*	-	+	*	-	-
Stockolm[3]	-	-	-	+	+	+	+	+	-	-	-
Göteborg	-	-	+	+	+	+	+	+	+	-	-
Austria[4]	-	+	+	+	+	-	+	+	-	-	-
Italy		+	+	+	+	+	+	+		-	-
Belgium[6]	-	+	+	+	+	+	+	+	-	-	-
Spain[7]	*	-	+	+	+	-	+	+	+	-	*
UK	+	+	+		+			+	*	+	+

Fig.16. Different clean vehicles definition

Legend:
+ considered as clean
- not considered as clean
* nobody can tell if it is clean or not, different definitions

[1] Martin Taushke
[2] Véronique Tatry, Gabriel Plassat
[3] In Sweden, it is up to the cities to decide about their environment policy. According to Björn Hugosson, these are the different definitions between Stockholm and Göteborg
[4] Manfred Woergetter
[6] Delphine Van Der Stricht, J.M. Jossart
[7] J.L.G Fierro

4-4) Barriers, incentives and recommendation for the clean vehicles spread

Clean air and cars sometimes seem like a contradiction in terms. New advances in cleaner fuels and engine technologies now make the ultra low emissions vehicle a practical proposition.

The real issue is how rapidly such ultra clean cars will be brought to the marketplace at affordable prices.

- **Favourable context**

The European Union is making new efforts to improve air quality and reduce vehicle emissions. All new model cars from the year 2000 will be required to meet new emission standards and use cleaner fuels proposed in draft Directives adopted by the European Commission in June 1996.

The favourable incentives to the clean fuel development are[1]:

- meeting Kyoto Objectives : 8% CO_2 reduction between 2008 and 2012 compared to 1990 rates
- doubling the share of renewable energy sources (from 6% to 12%)
- improving energy efficiency (increase by 18% until 2010 compared to 1995)

Over the past two decades the European Community has progressively strengthened its emissions standards for motor vehicles. Emissions from passenger cars meeting the latest standards enforced in 1996/97 will be 90% lower than those required in the 1970s. However, the combination of higher traffic growth and today's more stringent air quality goals has ensured that further tightening of European emission standards is inevitable.

- **EU incentives**

The European Commission strategy has four basic elements.

- firstly, new emission standards encouraging cleaner vehicle technologies.
- secondly, new fuel quality requirements to compliment the proposed vehicle standards.
- thirdly, improved inspection and maintenance to ensure the emission performance of vehicles does not significantly deteriorate - including On Board Diagnostics.
- fourthly, so-called local measures involving the possible application of fiscal incentives for cleaner cars, scrap page schemes of older models, road pricing, and traffic restrictions.

[1] In answer to "Draft Directive on liquid biofuels", "2003/30/EC" and "Green Paper : Towards a European strategy for the security of energy supply" – EU Commission

The new Directives on vehicle exhaust standards and fuel quality envisage two stages. Mandatory emission exhaust limit values are proposed for the year 2000 followed by more stringent target levels for the year 2005. To ensure that all new model passenger cars meet these air quality requirements further tightening of the standards and requirements of the Draft Directives is justified.

Improvements are needed to strengthen the following aspects of the Commission proposals:

- the vehicle emission requirements,
- the fuel quality standards,
- the systems for maintenance and durability,
- the provision of fiscal incentives.

- **National policies and taxes are the main barriers**

As it is explained in the biofuels part, the different systems of taxes and policies over Europe are a disincentive to the widespread of clean fuels and clean vehicles. Actually, the market is still blocked by the taxation's rates of each country (on cars and fuels). Moreover, as there is not a unique clean fuels definition, the biofuel market can't extend trough the borders of the producing countries (the European countries have different biofuels restrictions and compositions).

- **Making cars affordable**

Except for biodiesel, ethanol and biogas vehicles, building an ultra low emission vehicle today will require the best available technology that industry can provide. Precise estimates of the extra technology costs clean cars are a matter of some controversy. Estimates can vary between 200 € to 1000€ [1]for a medium sized car depending on the extent of the new technologies applied.

It is possible, therefore, that these extra costs could deter consumers from buying new cars that meet the most stringent emission standards.

Furthermore, higher costs may force car owners to extend the use of their existing vehicles. This would obviously delay necessary improvements in air quality.

The FIA believes that fiscal incentives would be the best way to promote clean cars and invest in air quality. They support using the 2000 and 2005 limit values as a basis for fiscal incentives and they believe that such incentives should be greater than the extra technology cost to ensure the rapid modernisation of the vehicle fleet.

[1] According to the FIA

4-5) Promoting clean vehicles

- **Clean mobility projects**

European clean mobility projects

CUTE[1]: The European Commission is allocating €18.5 million to the CUTE (Clean Urban Transport for Europe) demonstration project to support 9 European cities in introducing hydrogen into their public transport system. These cities want to demonstrate that hydrogen is an efficient and environmentally friendly power source for the future of their cities. 27 fuel cell powered buses, running on locally produced and refilled hydrogen should prove that zero emission public transport is possible today when ambitious political will and innovative technology are combined.

TRENDSETTER[2]**:** The European project Trendsetter involves 51 individual projects, all of which aim to improve mobility, quality of life, air quality, and reduce noise and traffic congestion. Five European cities participate to ensure real impact, by setting good examples and encouraging others to follow.

CLEANER Drive[3]: It is an RTD project that exploits the experiences, stakeholder contacts and market influence of national programmes on cleaner vehicles to develop European solutions on four topics: information to vehicle operators; vehicle environmental rating policy on infrastructure for gaseous transport fuels (hydrogen and natural gas).
The overall goal of CLEANER-DRIVE is to specify and test actions that remove barriers to market entry of new generation vehicles, with a particular focus on information barriers.

MIRACLES[4]: Miracles means to combine innovation, technology, and policies with the support of communication media so that with the active participation of citizens, traffic and energy consumption can be reduced as well as noise and air pollution

TELLUS[5] aims at increasing the modal share in favour of public transport and at increased bicycle use, congestion reduction, reduction of traffic related air and noise pollution below national and EC standards, reduction of inner city car kilometres, improvement of intra-organisational co-operation at city level, increase of political and public awareness, reduction of road casualties and improvement of public private co-operation.

ENERGIE-CITES[6]: Energie-Cités is an association of European local authorities, mainly municipalities. One of the aims of the association is to provide its members with information on the promotion of sustainable local energy policies. The network extends over 20 European countries and includes about 100 municipalities, the majority having between 100,000 and 300,000 inhabitants. Energie-Cités provides expert advice to municipalities, associations of cities, ministries, European institutions and private partners.

[1] www.cufuel-cells-club.com
[2] www.trendsetter-europe.org
[3] www.cleaner-drive.com
[4] www.miraclesproject.net
[5] www.tellus-cities.net
[6] www.energie-cites.org

Clean mobility actions at the national or local level

Several actions and projects have been set up by European countries in order to promote the clean fuels/vehicles use. Sustainable mobility is developed thanks to local or national actions as it is shown in the table below (*This list is not exhaustive*. It is some examples of actions obtained thanks to local and national contacts. Moreover some actions lead are just existing in some cities and not the entire country).A more complete table is available in the Annex.

MEASURES	Austria	Italy	Sweden	UK
Collective transportation				
Priority bus access routes			■	
Priority traffic lights for buses		®	■	®
Park and ride at the train or metro stations	■	®		®
Bus traffic lane	■	®		®
Clean vehicles				
Free parking for Clean Vehicles				
Free electric refuelling sites			■	
Parking only for CV		■		
Price reduction on the parking pass			■	
Possibility to borrow CV in order to test them			■	
Minimal proportion of CV in the municipal fleet		©		

Fig.17. Some examples of measures to promote clean mobility

Source: http://www.ifen.fr/sansvoiture/

Legend:

© Obligatory measures

® Recommended measure

■ Voluntary measure

- **New clean vehicles on the market**

The vehicle constructors understood that the clean vehicle market is becoming a new niche that interests more and more consumers. Moreover developing and proposing new clean models is favourable to their marketing image; that's why there exist today numerous models of clean vehicles.

The main constructors proposing such cars/busses/trucks are:

- **BMW**: environmentally friendly concept vehicles that run on hydrogen and electricity.
- **General Motors**: cars and trucks that can run on CNG, LPG, and E85 (and hybrid for 2004).
- **Toyota:** hybrid vehicles that utilise both gas and electric power sources
- **Honda:** new fuel-efficient, low-emission, HEV and hybrids
- **Nissan:** Eco-friendly vehicles include zero-emission, battery electric models
- **Opel:** CNG and fuel cells developments
- **Mercedes**: fuel cell technologies
- **Daimler Chrysler :** natural gas, ethanol, hybrids and electric
- **Hyundai**: development of battery electric, hybrid electric, and fuel cell technology.
- **Ford Motor**: environmentally friendly vehicles that run alternative fuels like natural gas, ethanol, electricity, hybrid and propane.
- **Volvo** currently produces bi-fuel vehicles that run on CNG and LPG. The company is also developing HEVs and AFVs that run on biogas, DME, electricity, ethanol, methanol, RME, and hydrogen
- **Renault**: development of alternative fuel and fuel cell technology.

Here are some examples of new vehicles existing on the market:

NISSAN
"*The Hypermini's* hyper-cute design masks one tough, serious vehicle, combining many advanced features and processes. Lithium-ion batteries (which are lighter and have a higher energy density than lead-acid or nickel-metal hydride batteries) reduce weight while still maintaining an impressive driving range. The revolutionary aluminium space frame is lighter and more rigid than a comparable steel body. Many of the Hypermini's plastic raw materials are actually recycled from end-of-use vehicles, using a process that Nissan pioneered. Finally, special tires let you drive up to 50 miles in case of a flat. Inside, the cabin is spacious and comfortable. We're sure you'll appreciate the Hypermini for its incredible combination of space-age technology and down-to-earth practicality."

RENAULT

"Kangoo: the electric versions, Electri'cité, Elect'road and LPG, put Kangoo in the clean vehicle category as well.
New Kangoo Express only needs a maintenance check once every 30,000 km. Like Mégane II, New Kangoo Express has adopted life-cycle environment management, intended to optimise the recyclability of vehicles at the end of their life-cycle in addition to working on the reduction of both fuel consumption and CO_2 emissions."

TOYOTA
"The *Toyota Hybrid System* uses advanced engineering to combine a gas engine with an electric motor to create an environmentally advanced, fuel-efficient, hybrid. A Super Ultra Low Emission (SULEV) rating that's up to 90% cleaner for smog-forming emissions than an Ultra Low Emission Vehicle (ULEV). A comprehensive warranty and the comfort and quality you expect from a Toyota. In fact, the vehicle never needs to be plugged in for recharging. No wonder over 100,000 is already on the road worldwide. "

VOLVO
"The introduction of the *Volvo Bi-Fuel* engine across almost the entire Volvo range will revolutionise the way we look at fuel. Volvo's Bi-Fuel engine runs on LPG or CNG and switches automatically to petrol when needed.
Volvo hasn't compromised on safety; every Bi-Fuel engine is factory fitted. Nor on boot space, the LPG/CNG tank is cleverly located underneath the floor. Not even on driving pleasure, the difference between driving on LPG/CNG or petrol is virtually undetectable. The main reason to value the Bi-Fuel is the environment. LPG and CNG have extremely low hazardous emissions, including CO_2, the main greenhouse gas. Admittedly, it can't run on water, but it is one step ahead of everyone else. Because preserving other species is the best way to preserve your own."

In order to have more information about the existing clean vehicles, see Annex 2 with the ENGVA report on "Examples of New generation Vehicles". You can also go on the Internet page (http://www.afdc.doe.gov/cgi-bin/doc_search/related2alt.cgi?41) where you have access to the main Auto Manufacturers Related Links.

CONCLUSION

Biofuels and Clean Vehicles are getting more and more developed across Europe, and as being renewable and less polluting they have a real potential of reducing some of the negative impacts of traffic. However, there is still a long way to go before Clean Vehicles are challenging regular vehicles in terms of availability and driving costs.

In order to speed up the introduction, there are many actions to take, the most important being reducing the extra costs through tax relieves and investment subsidies. Further incentives at local or national levels have proved to be successful.

The different views and policies on Clean Vehicles and fuels within Europe is a barrier to develop a breakthrough at the market, both by splitting the demand on Clean vehicles and by preventing the Clean fuels to develop a market at European level.

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Source: http://www.ifen.fr/sansvoiture/

ANNEX 2: ENGVA report on “Examples of New generation Vehicles”, 2002

Source: www.engva.org

Trendsetter Reports

This report is produced within the European project Trendsetter.
More reports from the Trendsetter project can be downloaded at www.trendsetter-europe.org:

2002:1, **Environmental Zones in Europe**, in english

2003:1 **Hammarby Sjöstad Logistik Center**, **Samordnad distribution på en stor byggarbetsplats**, in swedish

2003:2 **Clean Vehicles in Europe**. An overview of fuels, vehicles and national strategies, in english

2003:3 **Biogas as vehicle fuel– an European overview**, in english

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The European project Trendsetter involves 50 individual projects, all of which aim to; improve mobility, quality of life, air quality, and reduce noise and traffic congestion. Five European cities participate to ensure real impact, by setting good examples and encouraging others to follow.

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