Measures for the promotion of

BIOFUELS

premia

Introduction

Transport today faces serious challenges: security of energy supply, reduction of greenhouse gas emissions and improving its environmental performance, ensuring economic growth.

The future of energy supply for road transport is shadowed by possible imbalance between projected future crude oil production and consumption. Furthermore, greenhouse gas emissions of the transport sector are rising continuously and offset the reductions achieved in other sectors, thus putting the achievement of the Kyoto-protocol and longer term climate change targets at risk. Alternative motor fuels are seen as one option to assist the transport sector in reducing both its dependence on oil imports and greenhouse gases emission. Already in 2001, the European Commission set the objective of substituting 20 % of motor fuel consumption by alternative fuels by the year 2020. In the shorter term, biofuels are particularly promising, while hydrogen may have an important role in the long run. Natural gas could also provide an important contribution in the medium-term.

With regard to biofuels, the Council of the European Union recently adopted a binding target for the minimum share of biofuels to reach 10 % by 2020 in all Member States, complementing the indicative 5.75 % for 2010.

There are many barriers to the market introduction and large-scale application of these fuels, so major efforts will be necessary to reach the objectives. But at the same time a series of measures are available to accelerate the market entry and deployment. The European Commission's Biomass Action Plan (2006) and Energy Package (2007) identify the need for further action to support this.

PREMIA, a Specific Support Action funded under the 6th Framework Programme, investigated the effectiveness of different measures to promote market entry of alternative motor fuels in general and more specifically biofuels. PREMIA aimed at supporting the European Commission's on-going work on alternative fuels, such as the revision of the Biofuels Directive, while at the same time providing valuable information for all stakeholders involved in biofuel market introduction.

The European Commission is happy to present this booklet with the main results of the assessment of measures implemented for the promotion of biofuels. We hope the results will provide input into the discussion on a long-term, cost effective policy framework to support the market transition from conventional to alternative fuels for road transport.

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Director DG for Energy and Transport
European Commission

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Research Director
VITO, PREMIA coordinator

PREMIA : how to successfully

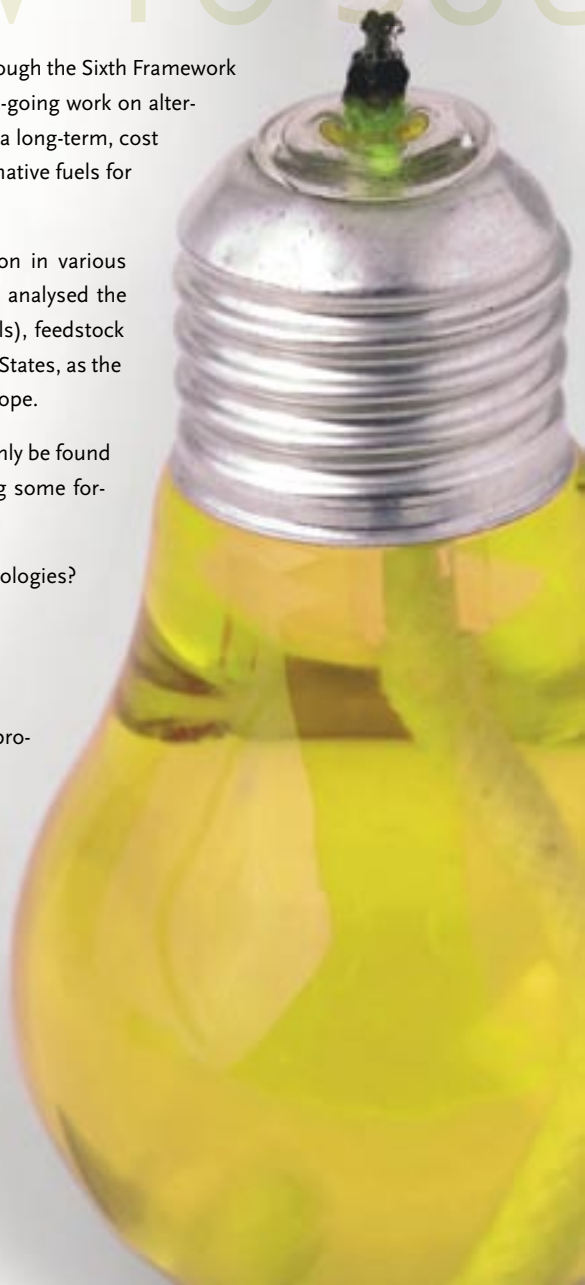
PREMIA (June 2004 – May 2007) is a project funded by the European Commission through the Sixth Framework Programme. The PREMIA project aims at supporting the European Commission's on-going work on alternative fuels. It provides input into the revision of the Biofuels Directive and discusses a long-term, cost effective policy framework to support the market transition from conventional to alternative fuels for road transport.

The assessment of measures and market conditions related to biofuels introduction in various European Member States formed a key element of the PREMIA project. The project analysed the production and consumption of biofuels, price evolutions (both for fossil and biofuels), feedstock production and the active policy measures and market conditions in different Member States, as the experiences gained are very valuable for the future deployment of biofuels all over Europe.

As the right mix of policy instruments for a wide market introduction for biofuels can only be found by looking both at the assessment of past policies while at the same time answering some forward-looking questions, the PREMIA project also looked at the following questions:

- What is the state of technology and should there be special support for some technologies?
- How far developed is the EU biofuel market?
- What are the key drivers for biofuel support and how to achieve them?
- What are the conditions that influence a Member State's potential and interest in producing and consuming biofuels?

In order to answer these questions, PREMIA grouped countries based on their economic strength, the energy situation and the natural suitability of growing bioenergy crops as well as the importance of the agricultural sector for the economy. In addition, possible future policy options were assessed on the basis of a number of scenarios for 2010 and 2020. These scenarios estimate the level of biofuel penetration for different levels of fossil fuel prices and different policy options, taking into account the impacts of biofuel production on the energy and agricultural markets (e.g. through increasing feedstock prices).



support alternative motor fuels

Preliminary results of the PREMIA assessment were discussed in depth at five regional stakeholder workshops held in Seville (16 Nov 2006), Athens (23 Jan 2007), Paris (2 Feb 2007), Tallinn (14 Feb 2007) and Cologne (1 March 2007). A final conference was held in Brussels on 2-3 May 2007.

For more information about the project, conference papers or final reports, visit our website at www.premia-eu.org.

PREMIA key info

PREMIA is coordinated by the Flemish Institute for Technological Research (VITO) and brings together the expertise of the following European research institutions: VITO (Belgium), the Joint Research Centre, Institute for Prospective Technological Studies (JRC-IPTS, Spain), the Centre for Research and Technology Hellas, Hellenic Institute for Transport (CERTH-HIT, Greece), Technical Research Institute of Finland (VTT, Finland) and South-East european Transport Research Forum (SETREF, Greece). These institutes are presented with their main activities on p. 35.

Working period	June 2004 – May 2007
Funding	Sixth Framework Programme

BIOFUELS, an INT

Biofuels, an introduction

What are biofuels?

Biofuels are liquid or gaseous fuels made from biological feedstock (biomass), such as agricultural crops agricultural and forestry by-products and the biodegradable parts of waste. Biofuels can substitute conventional fuels in vehicle engines – either totally, or partially in a blend.

Conventional and advanced biofuels

Biofuels are usually categorised into 'conventional' and 'advanced' biofuels.

The term '**conventional biofuels**' refers to ethanol from sugar or starch crops, biodiesel from vegetable oils, as well as biomethane and pure vegetable oil. The production of these biofuels is based on traditional chemistry such as fermentation and esterification, and other well-established processes that in essence are quite mature.

'**Advanced**' biofuels are the product of more technology-challenging processes that are still in the research or demonstration phase, at the same time implying great potentials with respect to life cycle energy, greenhouse gas emissions and cost reduction. Their main advantage lies in their ability to use a broad range of feedstock, including by-products, woody materials etc.

Biofuels in brief

Bioethanol is mainly produced by fermentation of sugar or starch crops, such as sugarcane, corn, sugar beet and wheat. It can be used in different ways to replace fossil-based gasoline: as low blends (up to 5 - 10 %) in the car fleet or high blends (85 % and above) in dedicated flexi-fuel vehicles, or as ETBE (ethyl tertiary butyl ether) to replace MTBE in the fuel production processes. Currently, around 75 % of bioethanol in Europe is used as ETBE. ETBE is less volatile than ethanol, but requires an additional production process step with isobutylene. Bioethanol and ETBE share the advantage of being high-octane products.

Advanced or lignocellulosic ethanol does not depend on a sugar- or starch-based feedstock, but can use a much broader variety of feedstock, such as straw, maize stalks and woody material. The lignocellulosic biomass is treated with enzymes and hydrolysis in order to extract sugar for ethanol production.While this process has not yet entered the market, it can build on major parts of conventional bioethanol plants. The final product is chemically identical with first generation bioethanol, but generally emits less greenhouse gas emissions on a well-to-wheel basis.

Biodiesel (also fatty-acid methyl ester, FAME) is mainly produced from oil crops (such as rapeseed and sunflower), waste cooking oils or animal fats. The extracted oils are converted by transesterification with an alcohol (usually methanol) to produce biodiesel. Biodiesel is used in diesel engines and can be applied in different blend rates with fossil diesel fuel. Blending up to 5-10 % is compatible with all existing diesel vehicles, for higher blends some changes to the engine and fuel system may be necessary (mainly rubber and plastic materials), but overall the required adjustments are minor. In Germany, hundreds of thousands of diesel vehicles are running on pure biodiesel.

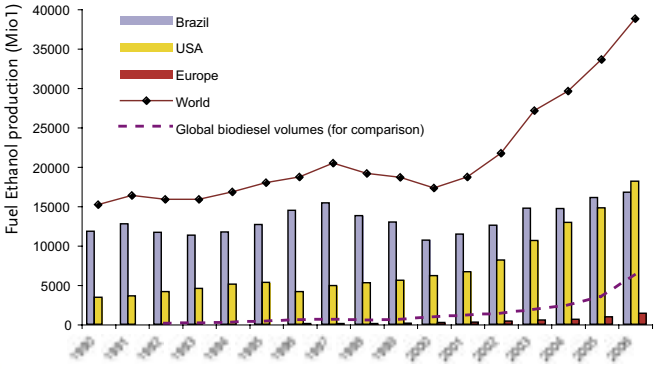
Advanced biodiesel (also known as synthetic biodiesel, Fischer-Tropsch biodiesel, or Biomass-to-liquid (BtL)) does not rely on vegetable oil as feedstock, but can make use of virtually all kinds of biomass. The Biomass-to-Liquid combines the gasification of biomass with a Fischer-Tropsch synthesis to derive a liquid fuel from the "syngas". The focus for automotive applications lies mostly on Fischer-Tropsch diesel. A similar process is also used to produce synthetic diesel on the basis of natural gas and coal. The final diesel product is actually superior to fossil diesel fuel (no sulphur, no aromatics, higher cetane number) and can be used in all levels of blends in conventional diesel engines. BtL processes are complex engineering projects and require many practical problems to be resolved before they become reliable and commercially viable. Currently, a number of pilot and demonstration projects are at various stages of development.

Biomethane is refined biogas. Biogas is produced by the anaerobic fermentation of organic matter in dedicated reactors. Very often, feedstock is organic waste such as livestock manure, food-processing residues, as well as municipal sewage sludge, but also energy crops (like maize) can be used. Biomethane can replace natural gas in gas-powered vehicles. So the introduction of biomethane in the transport market relies heavily on the success of natural gas technology in transport. So far, the use of biomethane as transport fuel has been successful mainly in Sweden, and in a number of local initiatives, for example Lille in France.

Pure Vegetable Oils from rapeseed or sunflower can be used in diesel engines. However, these need to be adapted in order to avoid engine problems. Currently, pure vegetable oils are often used for agricultural machines, especially in Germany. The use of pure vegetable oil as fuel for adapted private passenger cars or trucks is also most advanced in Germany, with an estimated number of 20,000 adapted vehicles.

Biofuels in the world and in Europe

There are mainly three large biofuel markets in the world: the USA, Brazil and the EU, with the first two focussing on bio-ethanol, while in the EU the biofuel market is dominated by biodiesel.



In the **United States**, ethanol produced from corn has been used as a transport fuel since the early 1980s, mainly pushed by concerns about energy security. The fact that the fuel is domestically produced is an important factor, and biofuels can reduce to some extent the major oil imports into the USA. Almost all ethanol in the US is used in the blend market at levels up to 10 % by volume (gasohol). Today, more than 30 % of the US gasoline is blended with ethanol. There are also applications of high ethanol concentrations (E85) and more than 4 million Flexi-Fuel vehicles are currently on the US market which are flexible to use either gasoline either E85. However most of these vehicles are running on gasoline.

After a steep increase in ethanol production, the US has become the global first producer by 2006. A major increase in US biofuel consumption can be expected for the future, taking into account the nationwide renewable fuels standard of the 2005 US energy policy act of 2005, which implies that ethanol use will almost double by 2012.

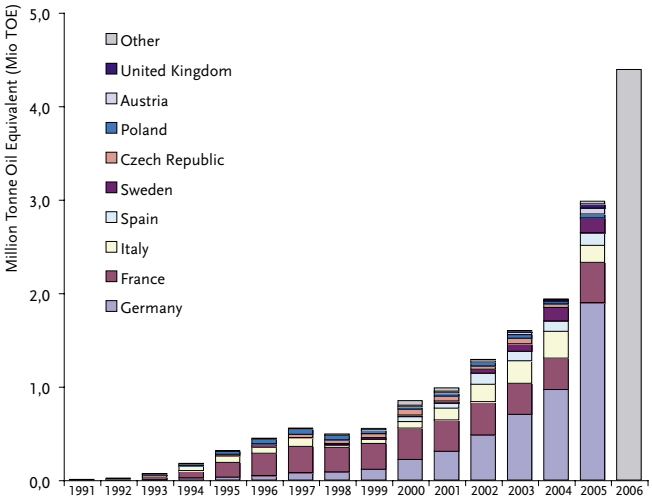
Production of sugarcane-based ethanol started in **Brazil** around three decades ago. By the mid 1980s, most new cars in Brazil were dedicated ethanol cars. At that period, ethanol was competing fully with gasoline. The trend toward ethanol changed in 1989 when a shortage in ethanol could not meet consumer demand. While the interest for dedicated ethanol vehicles declined, anhydrous ethanol was still generally blended with gasoline in concentrations between 20 and 25 % by volume. From 2003, flexible fuel vehicles (FFVs) were introduced to the Brazilian market. This has been a very important milestone, which created a revival of vehicles able to run on pure ethanol. In early 2005, the sales of FFVs surpassed the sales of gasoline cars, stabilizing around 80-85 % of car sales from 2006 onwards.

The **EU** biofuel market consists of many national markets with different trends regarding the type of biofuel used (ethanol or biodiesel, pure or low blends) and different production and consumption volumes. The production of biofuels is currently concentrated on a limited number of countries: 80 % of the total EU

ethanol and biodiesel production was achieved by only 4 (Spain, Sweden, Germany, France) and 3 Member States (Germany, France, Italy) respectively in 2005. Also in terms of biofuel consumption, there are major differences among Member States. By 2005, only Germany and Sweden achieved a market share of 2 % or above of total transport fuels, thus meeting the indicative target for 2005.

On an EU total, biofuel production more than doubled between 2003 and 2005 and the share of biofuels consumed reached a little over 1 % of all transport fuels in 2005, up from 0.5 % in 2003. Further significant growth can be expected, in particular when taking into account the 5.75 % target of the biofuels directive for 2010, which has been followed by most member states in their national biofuel targets. With the recently proposed target of a binding 10 % share to be reached by 2020, strong dynamics are also likely beyond 2010. Overall, trends indicate that biofuels are developing from a pioneering to a more mature market with large volumes.

Evolution of biofuel consumption in EU25
(fossil fuel consumption in 2004 = 287 Mio TOE)



Key drivers to promote biofuels

A biofuel policy should not primarily aim at fulfilling a certain target for biofuel consumption, but the key drivers underlying a biofuel policy must be kept in mind, namely to **increase energy security**, **secure domestic agricultural income** and **reduce greenhouse gas emissions**.

However, as Member States have different natural potentials and socio-economic frameworks that determine their interest and ability to produce and consume biofuels, they are likely to value these drivers differently. Therefore, governments may want to further steer the biofuels market so as to particularly promote pathways that fulfil their objectives.

Country specific conditions have a major influence in a Member States' interest and economic capability in supporting biofuel consumption and in its (agricultural) potential in producing biofuels. It is thus important to set into this context the assessment of past policies and – even more so – potential further strategies and individual targets.

Having in mind the main drivers for setting up a biofuels policy, in the PREMIA project the overall economic strength of a country combined with oil import dependency, greenhouse gas emissions and the importance of the agricultural sector were seen as the most relevant characteristics of a country with regard to biofuels. Even though additional factors such as collaboration of the domestic car manufacturers or a country's interest in pushing innovative biofuel technologies can have an important influence, a rough distinction can be made between the interest in increasing cultivation of biofuel feedstock and consumption of biofuels from the indicators above.

Depending on which policy driver is prevailing, the focus of the policy may change. For example, if support of the agricultural sector is a key-driver, it would make little sense to promote imported

biofuels by tax exemptions at the expense of revenue losses for the government.

The following chart suggests relations between the different key drivers for biofuel support and a biofuel strategy with regard to the share of imports and the share of advanced (second-generation) technologies. A green up arrow means a positive effect; a red down arrow means a negative effect.

	GHG EMISSIONS	SUPPLY SECURITY	AGRICULTURAL INCOME	INNOVATION	SOIL, WATER BIODIVER-
HIGH SHARE OF IMPORTS	▲▼	▼	▼	?	▲▼
HIGH SHARE OF ADVANCED BIOFUELS	▲	▲	▲▼	▲	▲

The impact of high shares of imported biofuels on **greenhouse gas emissions** (GHG emissions) is ambivalent. Currently, the most common imported biofuel – sugar-cane based ethanol from Brazil – is available at lower costs and often lower greenhouse gas emissions than domestically produced biofuels. However, depending on the origin of the imports and the production processes, this favourable trend might change in the future, if, for example, biofuel production leads to deforestation. Similarly, biofuel imports from other world regions can have higher greenhouse gas emissions than domestically produced ones. A policy that supports advanced biofuels is likely to contribute well to the key aim of lowering greenhouse gas emissions, as these technologies usually have lower per-unit greenhouse gas emissions than conventional ones.

In terms of a biofuel policy that primarily aims at enhancing the **security of supply**, increasing the share of imported biofuels seems counterproductive. Nevertheless, it needs to be pointed out that biofuels or feedstock can be imported from a broad range of countries, unlike oil, thus reducing the risks of supply. In the long run, it is also likely that there would be more advanced biofuels, as these can use a broader feedstock and thus have a larger potential.

Reducing import levels is certainly one impact if the focus of biofuels is to create **alternative outlets for agricultural products**. First generation biofuels may benefit from such a focus, as they depend on agricultural crops, while advanced biofuels would tend firstly to use cheap by-products before using dedicated agricultural crops. On the other hand, advanced technologies can make use of crops that can be grown on poor soils and in arid climates, thus opening up new opportunities for farmers. Furthermore, agricultural by-products can be converted (e.g. straw), which would ensure an additional income for farmers. However, as co-existence of conventional and advanced technologies can be expected in the medium term, the net effect on agricultural income is likely to be positive.

Supporting innovation will certainly focus on advanced technologies. Innovation, however, is not restricted to the processing technologies, but includes research on more efficient oil, starch and lignocellulosic crops, which in return may result in a reduction of imported biofuels.

Production of feedstock for biofuels can have an adverse impact on soil and water resources as well as biodiversity if grown in sensitive areas and without considering these factors. The impacts can be high for some imports (e.g. if a rainforest was transformed into arable land). On the other hand, growing energy crops on tropical lands can result in much higher yields and thus less demand for area. A general net effect of focusing the biofuel support on environmental functions cannot be deduced. There would be a clear impact with regard to the introduction of advanced biofuels. These would be pushed, as they can use a broader range of feed-

stock, in particular multi-annual crops (and by-products), which generally have a lower risk of erosion, and nutrient and pesticide leakage than annual crops.

Support measures for

ures biofuels

The production costs of biofuels lie above those of fossil fuels, even with current high crude oil prices. So biofuels need to be supported in order to enter the market.

Biofuels are supported on an EU and Member State level with the instruments being closely interlinked. While support to the agricultural production is carried out on an EU-level, in most other areas, the EU provides the framework (e.g. allowing tax exemptions on biofuels) and leaves the decision on concrete policy measures to the Member States. A successful policy needs to combine:

- investment security to the industry by a stable policy framework, e.g. by setting long-term targets;
- measures to build consumer confidence (e.g. by fuel standards, collaboration with car manufacturers to ensure compatibility and warranty);
- measures to reduce the final consumer prices of biofuels.

A wide portfolio of support policies and measures exists and will be necessary to combine investment security to the industry, trust of the consumer and price reduction.

Types of measures

Measures to promote the introduction of biofuel can be diverse:

- **regulatory, command or control measures**, e.g. quota systems, mandates, fuel standards ... ;
- **economic/fiscal measures**, e.g. direct subsidies, funding, tax incentives ... ;
- **procurement measures**, e.g. green procurement, leadership by example ... ;
- **collaborative measures**, e.g. networking, partnerships, voluntary agreements ... ;
- **communication or diffusion measures**, e.g. information and awareness campaigns, labelling, education and training ... .

The biofuel chain

Supporting measures for biofuel can be allocated at various stages of the biofuel chain:

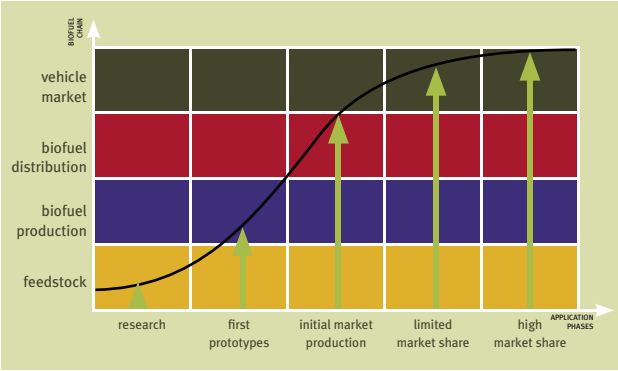
- cultivation of feedstock;
- biofuel production;
- biofuel distribution;
- vehicle market.

Application phases

In the process of biofuel market introduction, the following application phases are recognised, related to the market maturity of the technology:

1. research stage;
2. first prototypes (of vehicles and/or production installations);
3. initial market introduction (less than 1 % of market share);
4. limited market share (between 1 and 5 % of market share);
5. high market share.

The following pages depict datasheets for the main assessed biofuel support measures in PREMIA. For each measure, the following information is listed: brief description of measure, stage in the biofuel chain, application phase, impact and cost of the measure, pros and cons, prospects, experiences and a practical example.



Measure 1. Support to

One of the main concerns for biofuel consumption and production is the availability of the feedstock. The cultivation of energy crops can be promoted by the government through financial support programs. This is regulated at European level, the main instruments being the set-aside premium for the growth of non-food crops on set-aside land, and the energy crop premium of € 45/ha for energy crops cultivation on other land (up to a maximum of 1.5 million ha in the EU15, recently extended to 2.0 million ha for the EU27).

Stage in biofuel chain

Feedstock production

Application phase

Phases 3 and 4, up to limited market share

Impact

The *set-aside support* for non-food crops was applied in the EU15 from 1993. Until the year 2000, almost all biofuel feedstock was grown with set-aside support. The total amount was limited because of the Blair House agreement. Up to 900,000 ha set-aside area was used for biofuels (of which 300,000 in Germany; 300,000 in France).

The *energy crop premium* was initiated in the EU15 in 2004. The success of the premium was rather low at the start, because of the administrative burden for the farmers, the loss of flexibility to decide upon the use of the crop, and the relatively low amount of the premium. In the case of rapeseed, the energy crop premium would create extra revenue for the farmer of € 10-15 /tonne rapeseed, compared to a market price of € 200-250/tonne. Nevertheless in 2006, the maximum amount of 1.5 million hectares was almost reached.

Cost

The direct costs are carried by the government.

The effect of € 45/ha energy crop premium on the final cost of biofuels is limited to € 0,03-0.04/litre biodiesel and € 0.01-0.02/litre bioethanol.

Prospects

Feedstock support proved to be less effective than demand side measures to stimulate the market introduction of biofuels. Their effect on production cost is rather low and the extra revenue for the farmer limited. Support to agriculture is suitable as a complementary measure to help influence the choice of crops for energy feedstock, e.g. towards crops with a lower environmental impact. As agricultural policy is a common EU policy, the member states have only little influence in this domain.

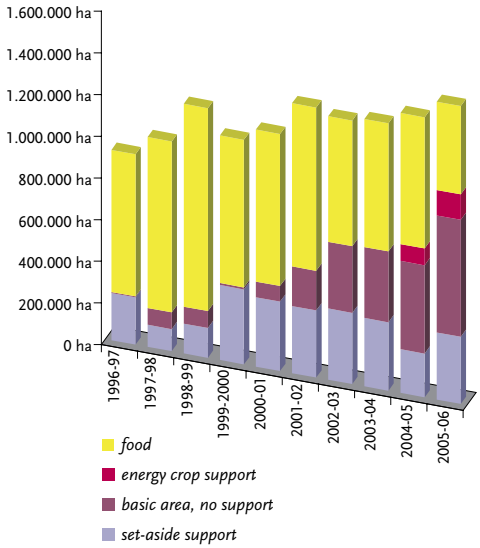
Experiences

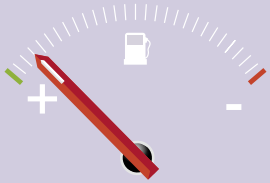
The figure shows the German rapeseed area used for non-food applications. This implies biodiesel or pure vegetable oil, oleochemistry and lubricants. Oleochemistry and lubricants generally account for around 100,000 ha of land. The relation with the European set-aside policy is very clear. In 1996, most feedstock was produced on set-aside land. The diminishment of set-aside obligations in 1998-1999 created a shortage

agriculture

of biodiesel feedstock, which was compensated for by some rapeseed cultivated on basic land. After the set-aside obligations were increased again, rapeseed cultivation as non-food crop rose again. After 2000, the German demand for biodiesel rose considerably, and it became interesting to grow rapeseed on basic area (no support) for biodiesel production. In the initial years of the energy crop premium (2004-2005), its success was rather limited.

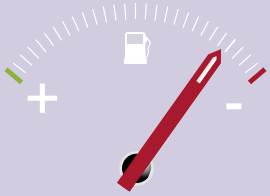
Rapeseed area for non-food use in Germany
(biodiesel, oleochemistry, lubricants)





PRO

- Complementary measure
- Reduced environmental impact, e.g. by promoting more environmentally-friendly cultivation or using lower quality arable land or areas with high erosion risk



CONTRA

- Can draw away crops from food production and increase their price
- Administrative burden for the farmer
- Less flexibility for the farmer in deciding upon the use of crops at the moment of harvest

Measure 2. Support to biofuel production

The production of biofuels can be stimulated by financially supporting production facilities, e.g. through capital grants. In the first stage of the technology (1990s for biodiesel and bioethanol, currently second-generation biofuels), R&D for production technologies and the first production facilities are financially supported with European, national and local funds. When the technology becomes mature, production facilities are generally no longer financially supported by the government.

Stage in biofuel chain

Production

Application phase

Phase 1 to 3, up to initial market introduction

Impact

Investment costs of current generation biofuels are relatively low compared to the operating costs (see further). If, for example, a typical large biodiesel production plant with an investment cost of 15-20 million euro is supported with 10 million euro, this would affect the biodiesel production cost by € 0.01-0.02/litre. So the impact on mature technologies is very limited.

For advanced (second-generation) biofuels like BtL, however, the investment for processing facilities constitutes a higher share of the total production cost. While capital costs account for some 7 % to 30 % of total production costs per litre for conventional biofuels (with lower capital costs for biodiesel and higher ones for ethanol), they are on the order of 60 % and higher for advanced biofuel production technologies. Here, the investment support can be used to influence the type of biofuels produced in order e.g. to accelerate the market introduction of advanced biofuels.

Cost

The direct costs of the support are carried by the funding party (government).

The effect on the total biofuel production cost is limited. Thus, governmental support for the construction of a production plant can be an impetus to new markets, but overall the cost is of low significance, especially compared to a tax reduction (see below).

Prospects

Governmental support for the construction of a production plant can be an incentive to investors. This could be significant in the future in launching the market for second-generation biofuels. For biodiesel and ethanol, technology that is already mature, investment support is less relevant.

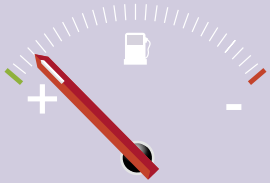
Experiences

Most countries with relevant experience in biofuel production (Germany, France, Austria, Sweden) supported biofuel production facilities through R&D or demonstration support, investment grants or cheap loans, mainly in the first years. Currently, the focus of support to production facilities concentrates on second-generation biofuels. For instance, the Swedish production plant for R&D ethanol production from cellulose received € 16 million from the Swedish Energy Administration.

The Czech Republic applied a direct subsidy to manufacturers of biofuel

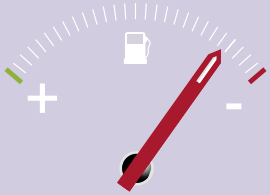
facilities

in the second half of the 1990s. This measure has been quite effective and created important biodiesel production capacity in the Czech Republic (which in previous years produced biodiesel for Germany).



PRO

- Appropriate to boost advanced biofuel production



CONTRA

- Low impact on the production cost for conventional biofuels
- Even when supported with local funds, production facilities may redirect their focus to external markets. This may also create unfair competition when the support differs between countries.

Measure 3. Fuel quality

Fuel quality standards are a necessary condition in establishing a market for alternative motor fuels. They create guidelines for producers, distributors and car manufacturers and eventually help to create consumer confidence in the product.

Stage in biofuel chain

Production/Distribution

Application phase

Phases 2 to 5, from first prototypes onward

Impact

All Member States with a successful biofuel support policy introduced national quality standards for biofuels at an early stage. This has led to European-wide standards (some still in preparation), which enable manufacturers and producers to focus on the European market rather than the individual ones. Cooperation between the different sectors is enabled: the fuel producers can match their production process to the necessary fuel quality, and car manufacturers can design their vehicle and engine models based on the fuel specifications of the alternative fuel, which also includes warranty considerations. In addition, the user knows that vehicle and fuel should be compatible.

Cost

Carried by the government and industrial parties.
Limited to the funding of preparatory research.

Prospects

Fuel standards are indispensable to ensure the future market penetration of any kind of biofuel.

At the same time, standards could also be used to ensure the environmental sustainability of biofuels (e.g. net GHG benefits; no loss of rainforest ...), which could help in the current debate on the sustainability of biofuels.

Currently a proposal at European level suggests that fuel suppliers should systematically reduce the well-to-wheel greenhouse gas emissions of fuels (1 % per year). This can be done e.g. through biofuels, so this could be an important instrument to promote biofuels with high greenhouse gas reduction.

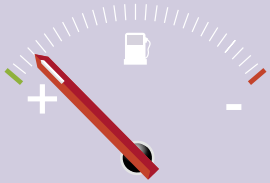
Experiences

Before the publication of the EU-wide biodiesel standard EN14214 in 2004, most countries active in the field had adopted their own standard. Austria was the first to create its own standard, followed by Germany, France, Czech Republic and Sweden. The European standard has become a reference for all biodiesel producers and car manufacturers. A similar EU-wide standard for bioethanol is in preparation. A uniform European standard is effective: it enables manufacturers and producers to focus on the European market rather than the individual ones.

On the other hand, current standards for fossil gasoline and diesel still limit the biofuel content to 5 % vol. The relative ethanol content in gasoline is determined by the EU Fuel Quality Directive, which allows a blending of up to 5 % by volume (3.4 % by volume). The maximum biodiesel content is limited by the CEN diesel standard EN590.

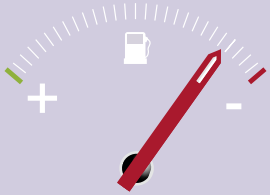
However, both pieces of legislation are in the process of being updated. A proposed revision of the fuel quality directive would allow a 10 % bioethanol share. Similarly, the Commission called for a revision of the EN590 norm.

standards



PRO

- Guideline for all stakeholders (fuel producers, distributors and vehicle manufacturers)
- Confidence for the consumer
- Fuel standards can support the environmental sustainability of biofuels, a current debate



CONTRA

- Limiting restrictions in current fossil fuel standards

Measure 4. Tax reduction

Reductions or exemptions from fuel taxes for biofuels have been a key instrument in supporting biofuels in many countries. Following the European Energy Taxation Directive of 2003, the reduction level is limited to the fuel tax, and overcompensation is not allowed.

Stage in biofuel chain

Distribution

Application phase

Phases 2 to 4, up to a limited market share. For a high market share, differentiation is still possible according to energy content (energy content per litre of ethanol is 2/3 of gasoline) and possibly also according to the external impact.

Impact

Tax reduction can make biofuels cost-competitive compared to their fossil alternative. As fuel taxes vary among Member States, this instrument has proven successful in countries with tax levels (and subsequent tax reductions) high enough to compensate for the additional production costs of biofuels. An increase in fossil fuel tax can give extra room for a tax reduction; however, there may be some side effects as well (competitiveness of the local transport sector). This relation becomes very clear in Germany, where the introduction of an increasing ecotax on fossil fuels from 1999 onwards led to an important subsidy level for biofuels that eventually lead to biodiesel pump prices being below those of fossil diesel.

From the table below (situation 2005), it can be concluded that all Member States with a high level of biofuels introduced a tax exemption combined with relatively high taxes on fossil fuels. However, the reverse does not seem to be true, which indicates that a tax exemption alone will not be sufficient to reach a high share of biofuels.

	Biodiesel tax reduction	Biodiesel consumption compared to diesel	Ethanol tax reduction	Ethanol consumption compared to petrol
	€/litre	% energy	€/litre	% energy
Germany	0.47	6.05	0.65	0.55
France	0.33	1.22	0.38	0.54
Austria	0.31	0.24 (before mandate)	-	-
Sweden	0.395	0.28	0.52	3.52
Spain	0.30	0.11	0.34	1.39
Czech	0.329	0.08 (2.8 % in 2000)	-	-
Poland	0.29	0.32	0.375	0.63 (1.1 % in 1997)
United Kingdom	0.30	0.14	0.30	0.21

Cost

The direct cost of the loss of fuel tax is carried by the government, and can be quite high (between € 0.30-0.40/litre diesel or gasoline displaced). This creates very high losses in tax revenue, especially when biofuels reach higher market shares. The loss in tax revenue in Germany in 2005 amounted to almost € 900 million for biodiesel. This is one of the main reasons why the German government decided to switch to an obligation system from 2007. Nevertheless, a major part of the revenue losses can be compensated by extra revenue related to the economic activity in the biofuel and agricultural sector.

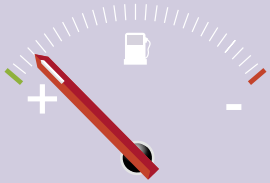
Prospects

Tax reduction has been one of the main measures for the current market phase of biofuels. With increasing volumes of biofuel consumption in all European member states, the revenue losses for the governments will become very important if they rely on tax reduction. A way of overcoming the revenue losses may be a simultaneous increase in the fossil fuel tax so as to make it budget-neutral for the government.

Many countries have decided to switch to a mandatory system, or a mix between tax reduction and mandates, so as to limit their tax revenue losses.

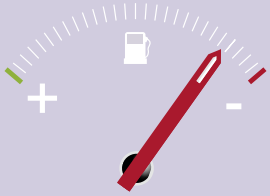
Experiences

Germany, for example had a system of full tax exemption for biodiesel (in pure form) from 1993. Until 1999 the tax reduction was hardly sufficient to compensate for the extra production cost of biodiesel. The main reason for consumers to switch to biodiesel was environmental consciousness. In 1999, the German government decided to introduce an increasing ecotax on fossil fuels from 1999 onwards, while biodiesel remained free from tax. This led to a situation where biodiesel pump prices were below fossil diesel prices.



PRO

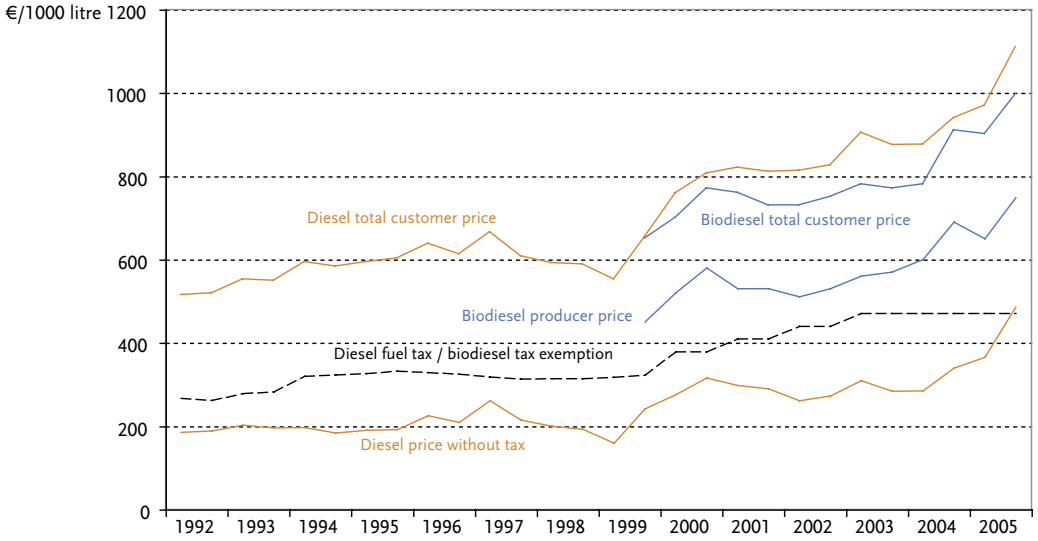
- Key instrument, well suited to initiate an 'infant' market
- Can be used to influence the type of biofuel to be introduced (differentiation for different biofuels)



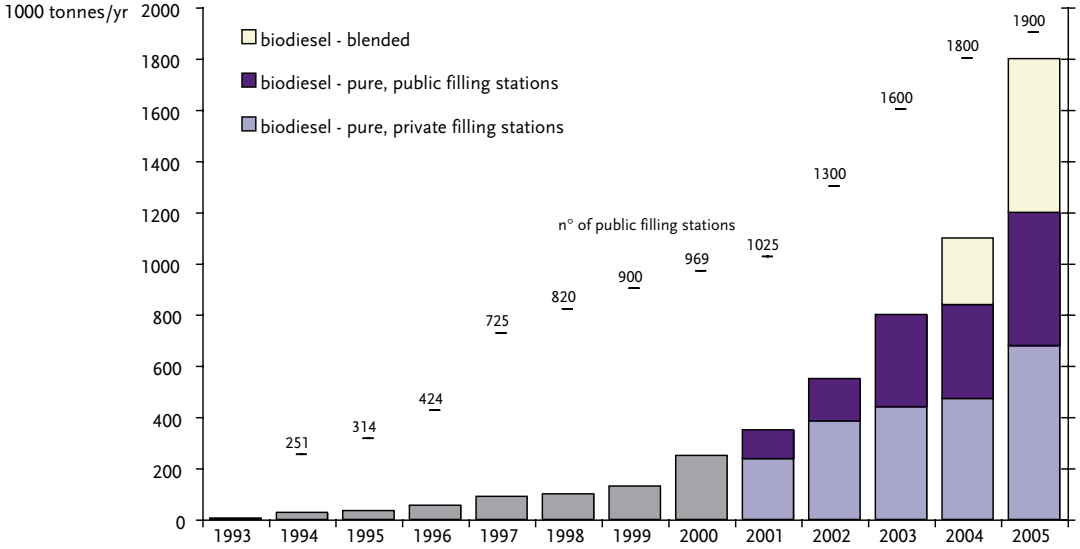
CONTRA

- High direct tax revenue losses for the government, unless compensated with tax increase on fossil fuels
- Risk of over- or under-compensation due to the volatility of crude oil prices
- System leaves a high degree of freedom to the market, and might be insufficient to reach high shares of biofuels

Evolution of diesel and biodiesel price in Germany



Biodiesel consumption in Germany



As a result, many consumers switched to biodiesel for economic reasons. From 2004, blended biofuels were also included in the tax exemption and low-blends rapidly gained an important market share.

The German government has recently adopted a new system to gradually introduce a tax on pure biofuels, and to introduce a mandate system for blending (without tax reduction) for fuel distributors from 2007.

Special case: Tax reduction with authorised quotas for biofuel producers

Biofuel producers can be authorized to produce a certain amount of biofuel to be placed on the local market with tax reduction. This is a special case of a tax reduction system.

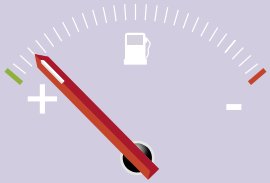
Through the quota system, governments can control the amount of biofuel on the market and limit its tax revenue losses.

Experiences

The authorised quota system has been applied in France and Italy, and was also recently adopted in Belgium.

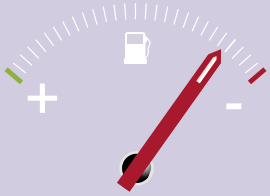
France is the main example for authorised quota systems for biofuels (biodiesel, ETBE and since 2004 also ethanol). Since the beginning of the biofuel story in France, a quota was assigned to biofuel production companies to give them the right to put a certain amount of biofuel (quota) on the market subject to a reduced tax. After a steady growth of biofuel production and consumption in France between 1993 and 1998, the quota system stabilized the amounts between 2000 and 2004. After 5 years of a fairly constant quota, France increased the authorised production quota (through a European call for tender system) in order to reach a biofuel share of 5.75 % in 2008, 7 % in 2010 and 10 % in 2015.

From 2005, a complementary system was implemented in France with the introduction of an extra tax (TGAP) for fuel resellers on their fuel sales if they don't reach a certain percentage of biofuels. The TGAP is a general tax on polluting activities on gasoline and diesel fuels, from which the biofuel components of fuels are exempted. It thus acts as a 'quasi-obligation' as it constitutes an economic sanction on fuel distributors who do not incorporate the prescribed level of biofuels.



PRO

- Stabilization of the biofuel market
- Long term security for producers and other market players
- Government controls budget loss through tax reduction
- Government can specify conditions for granting quotas, e.g. energy use, greenhouse gas emissions



CONTRA

- Administrative follow-up for the government
- Quota amounts depend on political willingness
- As the government 'controls' the market, private investments can fail to appear
- Risk of monopolisation by the major companies. Administrative burden for other parties to join the

Measure 5. Mandates for fuel

The most direct way of increasing the share of biofuels is by establishing obligatory substitution levels for the transport fuel sold to consumers in the EU. The obligation would fall to the oil companies/ fuel distributors to sell a certain share or a fixed amount of biofuels.

These mandates may be an obligation to:

1) add a certain percentage of biofuel to fossil fuel;

2) bring a certain quantity of biofuels on the market;

3) like 2), but with a tradable fuel certification system.

Option 1) is currently hampered by the fuel quality directive, which prescribes maximum contents of biofuels in the gasoline and diesel content, so options 2 and 3 are most relevant.

In order to accelerate the availability of dedicated filling stations for high biofuel blends (e.g. E85, biomethane, biodiesel), an analogue approach can be followed, e.g. by mandating fuel distributors to offer at least one renewable fuel (see Sweden).

Stage in biofuel chain

Distribution

Application phase

Phase 4-5, limited market share or higher

Impact

Mandates for fuel suppliers lead to a fast market response on condition that supply of feedstock and biofuel is assured. However, when quotas are set too low, mandates can restrict the market. Industrial sectors are generally not in favour, so it can be expected that goals will be reached with some delay.

Cost

In theory, the average cost for each litre of conventional fuel displaced would be similar to the one in the tax reduction case, the main difference being that the effects on the government budget would be almost neutral (apart from implementation and monitoring costs, and second-order effects from the other impacts). Costs would be carried by the oil industry and eventually be passed on to the final transport users through higher fuel prices ("polluter pays" principle).

Prospects

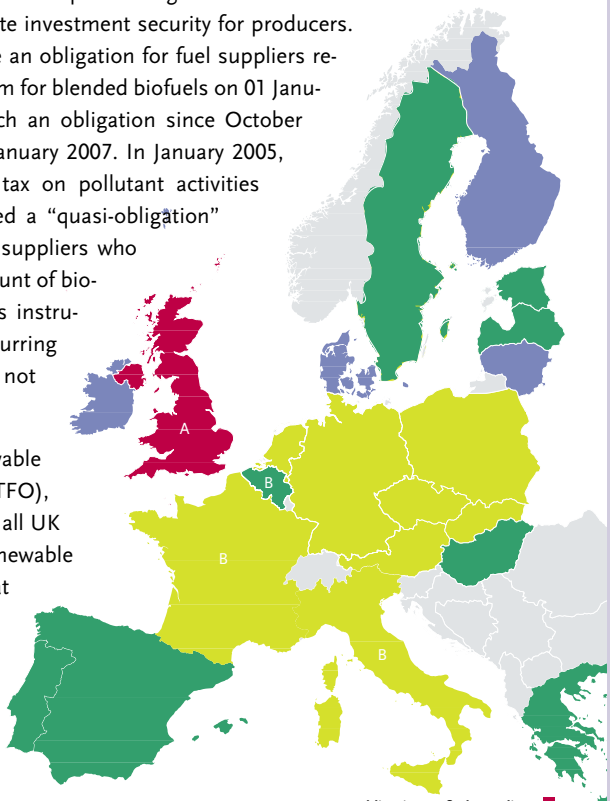
One of the major advantages of the obligation to fuel suppliers is the predictability of the market volumes that will be reached in a certain year. As the fuel supplier is obliged to fulfil the quota, it is very likely that this will be met, unless an alternative mechanism seems more attractive. An obligation system thus sets a long-term, predictable framework to the biofuel producers that consequently have a higher investment security than for tax exemptions, which can be revised every year, depending on the States' income needs.

suppliers

Experiences

Currently, a number of Member States are in the process of developing obligation systems, especially in order to prevent high revenue losses due to tax exemptions, and to create investment security for producers. These include Germany, where an obligation for fuel suppliers replaced the tax exemption system for blended biofuels on 01 January 2007. Austria has had such an obligation since October 2005, the Netherlands since January 2007. In January 2005, France introduced a general tax on pollutant activities (TGAP) that can be considered a "quasi-obligation" system in the sense that fuel suppliers who do not incorporate a fixed amount of biofuels have to pay the tax. This instrument acts like a penalty occurring when an incorporation rate is not attained.

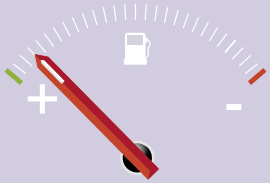
The UK is preparing a Renewable Transport Fuels Obligation (RTFO), which requires that 5 % vol of all UK retail fuel will come from a renewable source by 2010. To ensure that biofuels are sourced sustainably, the Government proposes to develop a carbon and sustainability assurance scheme as part of the obligation. An oil company will receive certificates from an administrator to demonstrate how much biofuel it has sold. If the company sells more than its 5 % obligation, it would be able to sell those certificates to other companies.



Obligation to fuel suppliers
Mixed system
Tax exemption (partial or total)
On-going or expected changes in support policy

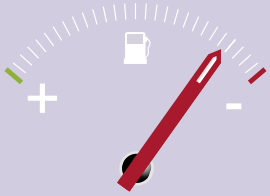
Notes:
A) The UK will introduce an obligation as from 2008 (Renewable Transport Fuel Oblogation)
B) Authorized suppliers only

Sweden has made a mandate for filling stations to offer at least one renewable fuel. This measure has increased the number of E85 filling stations to more than 800 in 2007.



PRO

- Efficient tool to stimulate growth
- Can be applied to mature markets too (no revenue losses for the government)
- Stable investment framework for biofuel suppliers
- No overcompensation possible



CONTRA

- Difficult to implement (reluctance, control)
- Favours lowest cost options:
- May lead to more imports
- Less incentives for innovation
- Less incentives for innovation (complementary measures needed)

Measure 6. Procurement

Procurement systems are important to get alternative or 'environment friendly' types of vehicles on the market. Examples are vehicles compatible with high concentrations of ethanol (E85) or biodiesel (B100), natural gas vehicles and hydrogen (fuel cell) vehicles. This measure interferes at the level of public vehicle procurement. Several systems can be distinguished:

1) public green procurement, i.e. the purchase of clean vehicles for public fleets, can be voluntary or mandatory;

2) common procurement by large numbers of users forming purchasing consortia with greater negotiating power;

3) leadership by example, i.e. initiators of a market introduction programme (governmental bodies or private parties such as manufacturers) promote clean vehicles by using them themselves.

Stage in biofuel chain

Market

Application phase

Phase 2 to 4, up to limited market share

Impact

Market initiators are important to create visibility of a new technology and bring experience and confidence to the market. Public fleets can play a major role in this process.

Cost

Carried by vehicle owners and users

The extra cost for biodiesel or ethanol compatible vehicles is limited, for gaseous biofuel it is somewhat more. In addition, infrastructure building for the public fleets may add to the cost. Extra costs can be compensated for by user incentives.

Prospects

Procurement methods are already applied by several Member States. At European level, a proposal for a Directive on the promotion of clean road transport vehicles has been prepared, which would oblige public bodies to allocate a minimum quota of 25 % of their annual procurement of heavy vehicles to enhanced environmentally friendly vehicles (EEV standard).

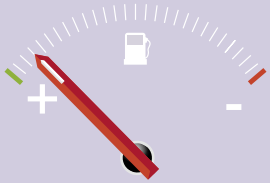
Experiences

Sweden implemented a mandatory environmental policy for government fleets. In 2005, at least 25 % of all new government vehicles must be 'eco-friendly', in 2006 this should amount 35 %. On the other hand, there are several examples of government fleets that voluntarily invested in alternative fuel vehicles to set an example. E.g. ethanol and biogas fleets in the public transport system in Stockholm, B30 in various French cities, biodiesel in the city of Graz (Austria), biodiesel in the city of Luxembourg, biogas vehicles in Lille (France).

Example

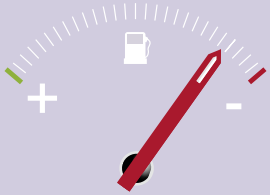
In 1998, Sweden called for tenders for flexible fuel vehicles (FFVs) based on ethanol. Ford was the successful bidder, and an agreement was signed for the purchase of more than 3 000 Ford Focus FFVs. Ford started delivering the first FFVs at the end of 2001. At the beginning of 2003, the level of 3 000 vehicles was reached and until 2005 it sold an estimated 20 000 FFVs in Sweden. From the second half of 2005, other manufacturers (mainly Swedish) also entered the market with FFVs, and currently more than 10 % of new vehicles sales in Sweden are FFV.

Companies can adopt a 'leadership by example' attitude too. The group PSA Peugeot Citroën in France has its internal diesel vehicle fleet – about 800 vehicles – running on B30.



PRO

- Efficient in creating visibility for initial markets, getting real world experience and building confidence
- Biofuel compatible vehicles create flexibility to switch between fuels, depending on availability and market price of fuels



CONTRA

Measure 7. Direct user

User incentives are of interest for promoting those alternative motor fuels that require an adaptation of the vehicle (such as pure or high-blends of biofuels, natural gas, hydrogen). They have proven to be a useful, yet complementary, measure to support the initial take-up of dedicated vehicles. However, once dedicated vehicles become common practice, such user incentives cannot be maintained.

Stage in biofuel chain
Market

Application phase
Phase 2 to 4, up to limited market share

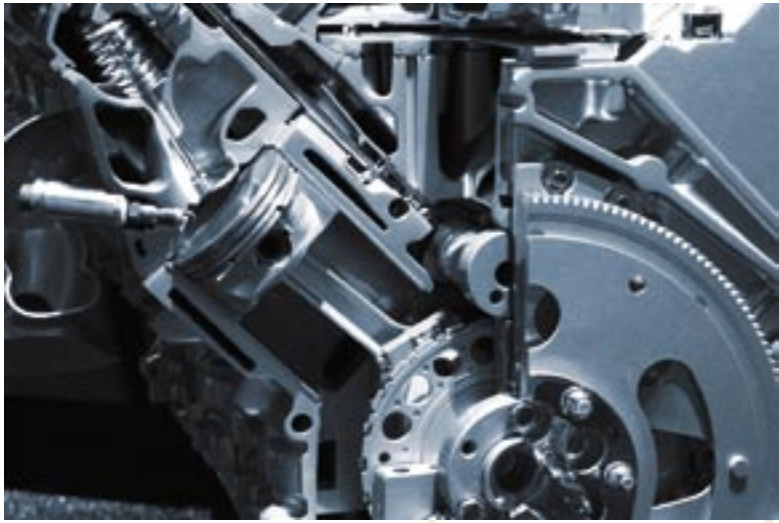
Impact
Direct user incentives create directly perceptible advantages for the consumer, which can lead to a high public response.

Cost
Costs are carried by the government (in some cases local), and overall costs are quite limited.

Prospects
User incentives are a useful means to introduce biofuel vehicles on the market up to a significant percentage of the fleet, for example 10 or 20 %. In the longer term, when biofuel vehicles become common practice, these incentives cannot be maintained.

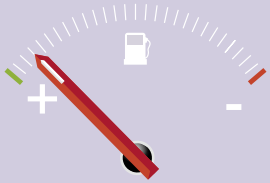
Incentives to purchase adapted cars, however, do not automatically imply that the users will consume alternative motor fuels. Therefore, user incentives are considered complementary measures. In Sweden, for example, they accompany the general tax exemption for biofuels.

Experiences
Sweden has introduced a set of user incentives to support eco-friendly vehicles. They enjoy an exemption in the form of the



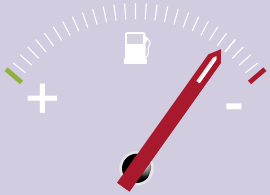
Stockholm congestion charge (trial), a 20 % relief with respect to company car taxation (for private use) and free parking in cities. On top of this, there is also the tax exemption for biofuels. The cost for the company car taxation reduction is estimated at about € 0.5 million/year, the advantage of free parking at around € 500 per vehicle per year for a typical user in Stockholm. The announcement of the exemption of the Stockholm congestion charge has boosted the sales of FFVs in Sweden. As a result, FFV vehicles constitute a share of 10 % of newly registered vehicle sales, and about 1 % of the total number of passenger cars are FFVs.

incentives



PRO

- High public response



CONTRA

- Complementary measure
- Only temporarily useful

Low versus high blends

Biofuels can be used either in low blends or in high concentrations (up to 100 % for biodiesel; E-85 or E-95 for ethanol). In most Member States, there seems to be a tendency towards low-blend fuels as implementation costs are lower than for pure biofuels due to the absence of additional distribution/storage costs. Furthermore, car engines do not need to be adapted.

For these reasons, low-blends can be implemented quite quickly once fuel distributors / petroleum companies are willing to co-operate. In France (biodiesel, ETBE), Germany (biodiesel blends since 2004) and Sweden (ethanol) it took only about 3 years to create a stabile, high volume biofuel market through low blends. Nevertheless, the conditions for the fuel distributors need to be clear (mandate, tax reduction, quota) and there should be enough motivation for fuel distributors to include biofuels (either by mandate, by tax reduction sufficient to cover extra costs or by a combination of both). The system could fail if the tax reduction is not sufficient or too low compared to neighbouring countries (UK, Austria, Czech Republic).

On the other hand, both Sweden (E85, biomethane) and Germany (pure biodiesel) demonstrated that a biofuel policy based on high blends can also be successful. Crucial in the developments is the cooperation of vehicle manufacturers in delivering compatible vehicles.

Compared to a general blending system, it takes much more time to reach a high volume biofuel market with high blends / pure biofuels. In Germany, it took almost 10 years to reach a 1 % share of diesel consumption through pure biodiesel. In Sweden, the share of E85 is still very modest, although an increase can be expected with the increased sales of FFVs.

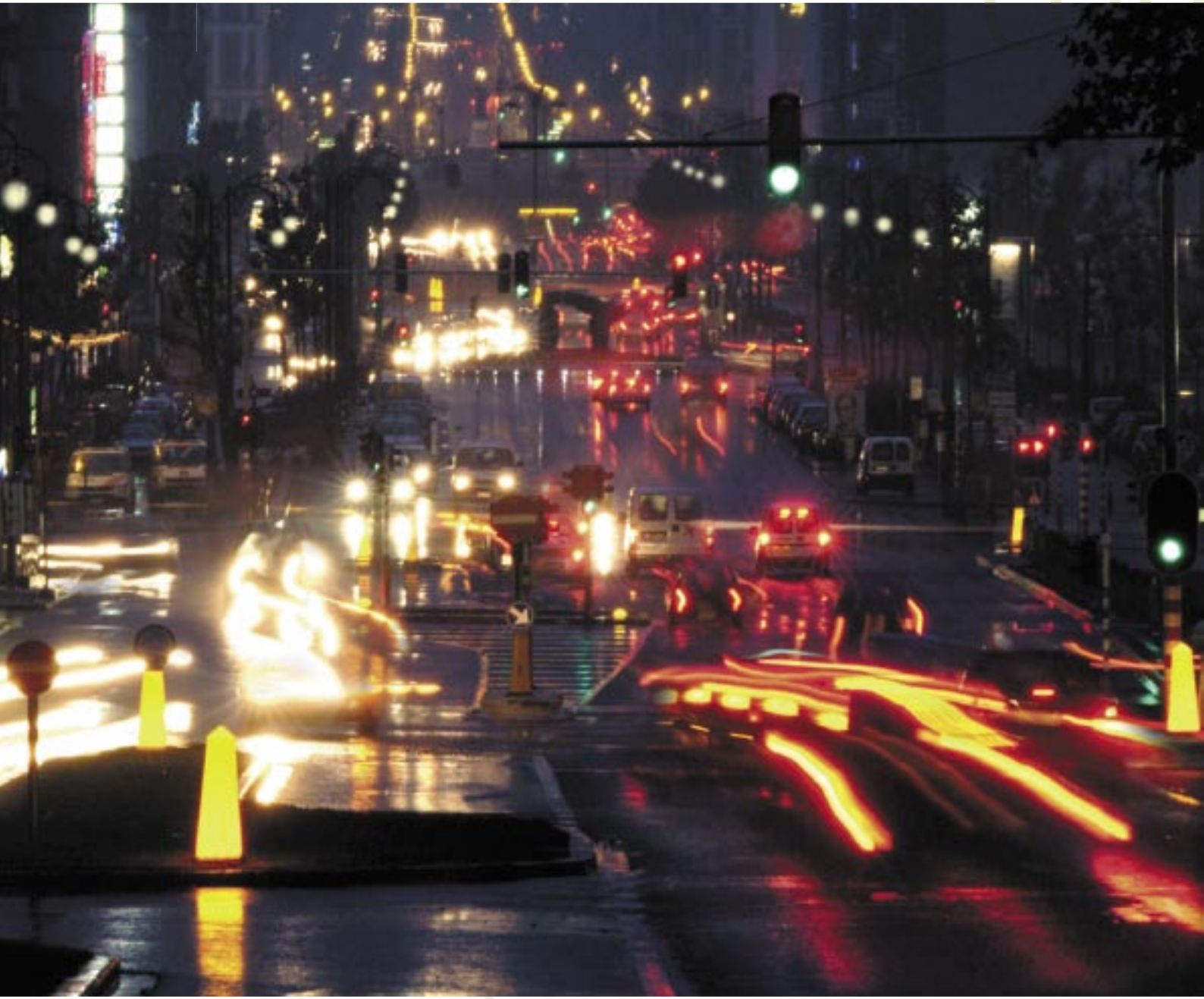
High blends can become necessary if ambitious biofuel targets are aimed at. Currently, fuel quality requirements limit the use of biofuels to 5 % of volume in fossil fuels (and 15 % for ETBE). Even though these limits are likely to be relaxed with the revision of the fuel quality directive, they can impede high biofuel shares.

Preparedness for the use of high blends might also be a means to enhance responsiveness to an abrupt increase in oil prices. The accelerated introduction of flex fuel vehicles would make it possible to react quickly to supply disruptions or price peaks of fossil fuels. As current new car models are still likely to be on the road at the end of the next decade, such a strategy would imply active support to increase the market share of cars that can run on high blends already today. This can be done by different policy instruments such as standards or incentives to the consumers/ car industry/fuel distribution sector.

Adapting the engine to high blends of biofuels can also help in reducing exhaust gas emissions. At the moment, engines are optimised for minimising emissions from the combustion of fossil fuels. As ethanol and biodiesel (FAME) have different properties, their combustion of low blends in unmodified engines can lead to changes in emission levels. Reducing the emission levels could be optimised in dedicated engines for high blends of biofuels.

Moreover, the use of pure biofuels is also important for increasing public awareness on biofuels.

In any case, it needs to be kept in mind that those Member States that achieved a significant share of biofuels supported pure biofuels (or high blends) as well as low blends. Regarding the fulfilment of future targets (and the limits for low blends), it is important to keep both options open.



Conclusions

A successful biofuel policy – at the level of Europe and in the separate Member States – results in a series of benefits. Taking into account the scarcity of fossil fuels and Europe's high dependency on oil imports, diversification and security of fuel supply is a plus. With transport being the sector with the fastest growing emissions of greenhouse gases, biofuels also bring an important environmental advantage, as they emit lower amounts of GHG than fossil fuels. In addition, local employment and agriculture benefit from the success of biofuels, especially when produced domestically.

In order to implement biofuels in the most cost-efficient way and to optimally affect security and diversity of fuel supply, an overall European approach is fundamental. Country policies need to be further streamlined within a European context.

The experiences in Member States with high shares of biofuel consumption in 2005 – Germany, Sweden, France and Austria – reveal that a mix of policies is necessary in order to successfully stimulate the biofuel market. A successful policy mix needs to simultaneously:

- create stable "technical" preconditions, such as fuel standards, fuel availability and compatibility with engines
- create a financial or regulatory framework that reduces the final consumer prices of biofuels to that of fossil fuels
- create long-term investment security for investors

Due to efforts from some pioneering countries and the EU, key preconditions for a wider market introduction are now fulfilled at EU level with the existence of fuel standards, the compatibility of engines to low blends and the availability of vehicles that can use high blends or pure biofuels. Furthermore, with the creation of substantial production capacities, market momentum has been created.

As a result, biofuels are now in the process of passing from an initial pioneering stage to a more mature market at an overall EU level, despite differences among EU Member States. Similarly, a wide range of mature technologies is available and more promising, advanced technologies are likely to enter the market in the coming decade.

Future biofuel support policy will need to be adapted to the situation of larger volumes being involved. It will therefore have to focus on

1. The most efficient policies and measures to promote biofuels. So far, subsidies through (partial or total) tax exemptions (complemented by other measures) have proven to be the most successful instrument in creating a market niche for biofuels. This has been the case particularly in countries with high taxes on fossil fuels, where the tax exemption could compensate the higher production costs of biofuels. While tax exemptions seem to be one key instrument in creating a niche market for biofuels, they may be too expensive for achieving high shares of biofuels. Therefore, a number of Member States recently changed to obligation systems.

2. Measures to influence the composition of biofuels and underlying production pathways in order to better meet the dominant objectives of a biofuel policy. Such measures are particularly important to complement e.g. an obligation scheme, which tends to favour lowest-cost biofuel options. While supply side measures have had a limited impact until now in developing market demand, they may be an appropriate tool to steer a growing biofuel market in the desired direction.

3. Combining national and EU biofuel policies is important to create long-term investment security. At the moment, progress in implementing a biofuel support policy varies substantially among Member States, as do the production and consumption volumes. In recent years, however, more Member States have introduced an active biofuel support policy and developed domestic production capacities. Despite different national objectives for promoting biofuels, this converging trend is likely to continue.

Moreover, regarding the fulfilment of the EU biofuel objectives, it is important to keep the opportunities open, and to consider both low blends and high blends or pure biofuels. There seems to be a tendency towards low blend fuels as implementation costs are lower and car engines do not need to be adapted. However, both Sweden and Germany have demonstrated that a biofuel policy based on high blends can also be successful. Moreover, the use of pure biofuel is also important for increasing public awareness of biofuels.

In addition, the sustainability of biofuels is an important item. Sustainability certification of biofuels, possibly based on a voluntary agreement with the fuel distributors, could contribute to demonstrating the advantages of biofuel. The image of biofuel is indeed a factor that is crucial to its permanent breakthrough on the market of transport fuels.

Partner presentations

VITO *Belgium*

- Flemish Institute of Technological Research

Area of Activity

- Research on alternative fuels and vehicle technologies
- Policy-oriented research focused on market barriers for AMF

Responsibilities in PREMIA

- Project coordinator
- Responsible for the assessment of international initiatives on alternative motor fuel (WP2) and the assessment of initiatives in the field of hydrogen transport applications (WP3)

JRC-IPTS *Spain*

- Joint Research Centre - Institute for Prospective Technological Studies

Area of Activity

- Policy-oriented research on sustainable transport, with focus on the impact of new/emerging technologies and the impact of new regulatory frameworks

Responsibilities in PREMIA

- Responsible for scenario calculations (WP6) and policy recommendations (WP7)

CERTH / HIT *Greece*

- Centre for Research and Technology Hellas / Hellenic Institute of Transport

Area of Activity

- Policy-oriented research in Transport field with focus on organization, operation, planning, infrastructure, standardization, economic analysis, management, vehicle technology, impact assessment, of land, maritime, air and multimodal transport services

Responsibilities in PREMIA

- Responsible for the assessment of initiatives for biofuels and natural gas (WP4) and the evaluation of country specific situations (WP5). Co-ordinates the work done through SETREF.

VTT *Finland*

- Technical Research Centre of Finland

Area of Activity

- Research on alternative fuels and new vehicle technologies. System-oriented research focused on energy use and supply in road transport including LCA and Well-to-Wheel studies.

Responsibilities in PREMIA

- Responsible for the state of the art of and indicators for AMF (WP1) and dissemination (WP8).

SETREF *Greece*

- South-East European Transport Research Forum

Area of Activity

- Networking of 32 Transport Research institutes in South-East Europe

Responsibilities in PREMIA

- Involved in assessment of initiatives on biofuels and natural gas (WP4) and country-specific situations (WP5), involved in regional dissemination for South-East European countries

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Reference and data sources:
Premia Policy recommendations, final deliverable,
Brussels, May 2007

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