Ministry of Economy and Business Affairs
Ministry of Finance
Ministry of Food
Ministry of the Environment
Ministry of Taxation
Ministry of Transport

# Statement on the implementation of the EU Biofuels Directive

June 2004

## Summary and conclusion

Under the EU Biofuels Directive, a decision has to be taken on the extent to which it is desirable to promote the use of biofuels for transport.

At present, bioethanol (produced from crops containing sugar and starch such as sugar cane, sugar beet, maize, wheat, etc.) and biodiesel (produced from oily seeds such as rape seeds, sunflower seeds, etc.) are by far the most common biofuels both globally and in the EU.

Small quantities of these fuels (up to 5%) can be mixed with petrol and diesel respectively and used by most of the existing vehicle fleet without any technical engine problems. Some difficulties may be encountered with older vehicles, however. There are also problems with observing certain environmental requirements when bioethanol is added to petrol.

Biofuels are far more expensive to produce than ordinary petrol and diesel. In addition to this, considerable additional investment is required in existing systems in order to handle the fuels during storage and distribution.

The difference in relation to the price of ordinary fuels can be offset for example by general tax rebates for biofuels.
Biofuels can also be used in public transport vehicles, etc. serving a clearly defined area, in which case subsidies and/or local tax rebates are necessary.

If biodiesel is completely exempt from tax, and similar rebates apply to other biofuels, the State will suffer an immediate loss of around DKK 250 million per year, if the use of biofuels in Denmark is 2% of the total sales of petrol and diesel for transport in 2005, the guideline reference value for the whole of the EU in the Biofuels Directive.
The loss of revenue will grow to around DKK 0.8 billion a year if Denmark meets the guideline reference value for biofuel sales of 5.75% in 2010. This is in addition to the costs of financing such a development.

Overall, biofuels are of no great benefit to the environment. Although biofuels are almost $CO_2$ neutral, this gain is out of all proportion to the additional costs. It would be far cheaper to reduce $CO_2$ emissions in other ways. Using the money saved by not promoting biofuels elsewhere will therefore be of greater benefit to the climate and the environment.

Moreover, energy crops for biofuels are sometimes grown on set-aside land, which puts a strain on the aquatic environment through increased leaching of nitrogen, phosphor and pesticides. There may also be increased emissions of ammonia and laughing gas (a greenhouse gas) into the air. This is in addition to the effect on biodiversity and natural amenities.

Danish biofuel production is mainly dependent on the size of the European market and the competitive position of the Danish producers.

Until now, efforts to promote the use of biofuels for transport in Denmark have taken the form of research into means of reducing the additional costs they entail in relation to fossil fuels. Amongst other things, therefore, this work may lead to biofuels becoming a cost-effective climate policy measure in future. This research has been and continues to be supported by the government. The Danish Energy Agency has started work on a Danish strategy for further research into and development of biofuel technologies.

At present, Denmark produces a certain amount of biofuels for export, but uses very little of them itself. As a result of political commitments, however, a considerable amount of biomass is used to produce electricity and heat, regarded until now as the most cost-effective use of biomass for energy production in Denmark. Denmark therefore lies well above the EU average in terms of the proportion of its total energy production produced using biomass. The amount will be further increased by virtue of decisions already taken.

Under the Biofuels Directive, Denmark must indicate to the Commission by 1 July 2004 the level of its indicative targets for the proportion of biofuels at the end of 2005. Under the Directive, Member States must ensure that a minimum proportion of biofuels and other renewable fuels is placed on their markets, and that national indicative targets are set to that effect. A reference value for this is 2% as at 31 December 2005, but deviations from this are possible. This means that a national indicative target could be zero. The reference value as at 31 December 2010 is 5.75%. The necessary measures must be effective by 31 December 2004. The Biofuels Directive points out that a particularly low proportion of biofuels may be explained by the amount of national resources used to produce biomass for energy use other than transport.

The government plans to abolish the $CO_2$ tax on biodiesel and introduce similar tax rebates for other biofuels for transport.
There is no $CO_2$ tax as such on petrol. In order for biofuels added to petrol to be exempt from $CO_2$ tax, the energy tax must be divided into a $CO_2$ tax and a correspondingly reduced energy tax. The total taxes on ordinary petrol and diesel will not therefore be affected.

This is the right solution, as it takes full account of the fact that biofuels are almost $CO_2$ neutral, and fits in with other Danish climate policy measures.

The tax rebate will therefore specifically relate to the $CO_2$ value of the biofuels. In the present market, however, this does not appear sufficient to encourage any notable use of biofuels. The

reflection of this is that at present, the promotion of biofuels is not a cost-effective environmental policy measure.

The situation may change, however, if there is a breakthrough in the research and development work, or a sharp rise e.g. in oil prices. Rising prices on the future EU market in $CO_2$ allowances may also change the situation.

The government therefore intends to inform the Commission that Denmark's indicative target for the use of biofuels in 2005 will be zero.
This decision is in keeping with the government's position during the negotiations on the Directive. Here, Denmark was instrumental in replacing the obligatory targets for the use of biofuels contained in the original proposal for a directive with optional targets in view of the fact that the cost-effectiveness of such measures varies from country to country, and that obligatory targets are not cost-effective.

In the longer term, developments in biofuel technology or changes in the energy markets may change the outlook for and the costs of using biofuels. Developments will therefore be closely monitored in coming years with a view to fixing the indicative target for 2010 in 2006. The Danish Energy Agency's future research and development strategy for biofuel technology will be a pivotal element in this connection.

## 1. Biofuels and the Biofuels Directive

EU Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport was adopted in 2003. The stated purpose of the Directive is that these alternative fuels should replace a certain amount of petrol and diesel for transport. The Directive uses indicative targets for the use of biofuels, which are currently far more expensive to produce than ordinary petrol and diesel, and which are not therefore generally available for sale without some form of support. The difference in price can be offset for example by general tax rebates for biofuels, as a result of which the State would suffer a considerable loss of revenue. In implementing the Biofuels Directive, the government is bound *inter alia* to indicate, by 1 July 2004, Denmark's indicative targets for the use of biofuels in 2005. The Directive gives a reference value of 2% for this, but deviations from this are possible.

### 1.1. Biofuels and other renewable fuels for transport

"Biofuels" are liquid or gaseous fuels for transport produced from biomass. The biomass may be specially cultivated for the purpose, but may also consist of biodegradable waste products and waste. "Other renewable fuels" are renewable fuels, other than biofuels, which originate from renewable energy sources.

There are many different biofuels, which can be produced in many different ways. At present, bioethanol (produced from crops containing sugar and starch such as sugar cane, sugar beet, maize, wheat, etc.) and biodiesel (produced from oily seeds such as rape seeds, sunflower seeds, etc.) are by far the most common biofuels both globally and in the EU.

### 1.2. The Biofuels directive

Under the Biofuels Directive, Member States must ensure that a minimum proportion of biofuels and other renewable fuels is placed on their markets, and that national indicative targets are set to that effect. There is therefore no legal obligation to use biofuels.

A reference value for Member States' targets is 2%, calculated on the basis of the energy content of all petrol and diesel for transport purposes placed on their markets by 31 December 2005. The reference value for 31 December 2010 is 5.75%.

Under the Directive, each Member State must also:

- report to the European Commission, by 1 July each year, inter alia on measures taken to promote the use of biofuels for transport, and the proportion of biofuels used in the previous year.
- fix national indicative targets.
    - The target for 2005 is indicated in the report of 1 July 2004. The necessary laws and administrative provisions must enter into force no later than 31 December 2004.
    - The target for 2010 is indicated in the report of 1 July 2006.
- monitor developments and ensure compliance with emission standards.
- inform the public about the availability of biofuels.

The Directive recommends that national measures should consider the overall climate and environmental balance of the various types of biofuels, while also taking account of cost-effectiveness, competitiveness and security of supply.

Table 1 shows that 2% of the total consumption of petrol and diesel for transport (road, rail and domestic maritime transport) in 2005 is expected to be 3.4 PJ. The 2010 target corresponds to 10.4 PJ.

**Table 1. Consumption of petrol and diesel for domestic transport, and reference targets**

| | **2002** | **2005** | **2010** | **2002** | **2005** | **2010** |
|---|---|---|---|---|---|---|
| | ----------PJ---------- | | | ----------Billion litres---------- | | |
| **Consumption** | | | | | | |
| Petrol | 84 | 91 | 96 | 2,6 | 2,8 | 2,9 |
| Diesel* | 78 | 79 | 84 | 2,2 | 2,2 | 2,3 |
| Total | 162 | 170 | 180 | | | |
| **Reference targets** | | | | | | |
| Total | | **3,4** | **10,4** | | | |

| | | | |
|---|---|---|---|
| (%) | (2%) | (5.75%) | |

* Inter-ministerial work is being carried out to check data on the use of diesel by the transport sector.
Source: the Danish Energy Agency: *Energistatistik 2002*, and the Danish Road Directorate: *Vejdirektoratets transportfremskrivning*, September 2002, and own calculations

## 1.3. Parallel provisions in the Energy Taxation Directive

The year 2003 also saw the adoption of Council Directive 2003/96/EC restructuring the Community framework for the taxation of energy products and electricity (the Energy Taxation Directive). The Directive provides for the full or partial removal of national taxes on biofuels for a period of 6 years, with the possibility of renewal.

Tax rebates are also permitted for local public passenger transport (including taxies), waste collection, the armed forces and public administration, the disabled and ambulances. The provisions are not specially geared towards biofuels, and the reduced rates may not be less than the minimum levels of taxation prescribed by the Directive. Member States like Denmark, which have a lower rate or exemption for buses may continue to apply the exemption or lower rate even if they are below the levels prescribed by the Directive.

Under the Energy Taxation Directive, the scope for granting tax rebates and exemptions will lapse should Member States be required by Community law to comply with legally binding obligations to place a minimum proportion of biofuels on their markets.

## 1.4. Other recent EU decisions

According to the Presidency conclusions, the Brussels European Council of 20 and 21 March 2003 (point 54) "…welcomes the agreement recently achieved on the Directive on the promotion of biofuels for transport, endorsing the setting of national indicative targets consistent with the reference value of 5.75% for the use of biofuels by 2010 for transport purposes."

## 1.5. The background to the Biofuels Directive

According to the text of the original proposal for a Directive, its main objectives were to contribute to[1]

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### Security of supply of transport fuel

Today, the transport sector is almost entirely dependent on fossil fuels. The Commission regards gradually phasing in biofuels from a market share of 2% in 2005 to 5.75% in 2010 to be the first stage in this process. The Commission anticipates that phasing in natural gas in the longer term and hydrogen in the very long term will help to achieve the 20% target.

[1] COM(2001) 547, 2001/0265 (COD), p. 39.

Despite the fact that biofuels are far more expensive to produce than petrol and diesel, they can be phased in more quickly and cheaply than other existing alternatives. Biofuels such as bioethanol and biodiesel are produced using familiar, tested processes. Small quantities of these fuels can be mixed with petrol and diesel respectively and used by most of the existing vehicle fleet without any technical engine problems. In some older vehicles, however, it may be necessary to replace fuel pipes which are not resistant to blended fuel. There may also be an environmental problem with regard to conforming with the specification for vapour pressure when mixing bioethanol with petrol: see section 1.7. The existing fuel distribution system can be used, but considerable additional investment will be required for bioethanol in particular, cf. section 1.7.

By virtue of its North Sea reserves, Denmark can expect to be more than self-sufficient in oil until the "expiry year" of the Biofuels Directive in 2010. Denmark is also expected to be self-sufficient in energy as a whole, *inter alia* because sustainable energy production is expected to continue to account for around 14% of total energy consumption. This high proportion is due amongst other things to the use of biomass in electricity and heat production. As an oil and energy exporter, Denmark is less affected by problems with the international supply of oil than most other Member States. In the longer term, however, security of supply could become a problem once more, which biofuels alone would not be able to solve.

### Reducing $CO_2$ emissions

Burning biofuels releases no more $CO_2$ into the air than the biomass absorbed when it was growing. Biofuels are not 100% $CO_2$ neutral, however, as more greenhouse gases are typically emitted during the production of biofuels than during the production of fossil fuels.

The conclusion is that promoting biofuels for transport is not a cost-effective climate policy tool in Denmark, as the calculated cost of achieving the $CO_2$ reductions is typically far higher than the indicative sum of DKK 120/tonne $CO_2$ in the government's climate strategy. The results of the calculations are essentially dependent on assumptions about developments in the prices of crude oil and energy crops, etc., see section 3.

Moreover, when the original proposal for a Directive was presented, the European Commission emphasised that "any cost-effective strategy to reduce oil dependency and $CO_2$ emissions from the transport sector will have fuel efficiency as its top priority."[2]

### Rural development and maintenance of employment in the rural community

Promoting biofuels increases demand for agricultural products and thus generates agricultural income and employment financed by the support required for the biofuels.

The extent and composition of Denmark's future biofuel production will largely depend on demand on the coming EU biofuels market and the competitive position of the Danish producers. It is not possible to state with any certainty at this stage how or by whom a particular Danish or European demand for biofuels will be covered.

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[2] COM(2001) 547, 2001/0265 (COD), p. 4.

In as far as biofuels are imported, the positive effect on Danish agriculture will be less certain. Biofuels can be produced competitively outside the EU, but common EU customs regulations go some way towards neutralizing the effect of this, see section 3. In any case it is doubtful whether there would be any increase in total employment, particularly in the long term, by stimulating demand for biofuels in Denmark.

## 1.6. Other environmental aspects of biofuels

### Other emissions into the air from burning motor fuels

When it presented the proposal, the European Commission considered that in theory, the future use of biofuels would only result in a small reduction, if any, in harmful emissions to the air other than $CO_2$ (CO, $NO_x$, VOC and particles). Amongst other things, this is due to the fact that the environmental regulation of these emissions has been and continues to be tightened.[3]

### Environmental effects of cultivating biofuel crops on set-aside

If biofuel crops are grown in Denmark, the extent to which they will be cultivated on areas in rotation or set-aside areas is uncertain: the latter is possible as they are non-food crops. The specific crops in question are also unknown. The uncertainty is due to the changeable market conditions, and the fact that relative prices will be affected by growing demand for energy crops in the EU. As mentioned above, it should be emphasized that there is no direct link between the demand for biofuels in Denmark and Danish production, and thereby the environmental effects of cultivation in Denmark.

If energy crops are cultivated on ordinary land in rotation, they replace the other crops, and the net effect on the environment can be assumed to be minimal. The reform of the EU agricultural policy improved the incentive to cultivate energy crops on rotation land, as it triggers an additional subsidy of €45/ha. The subsidy is limited to 1.5 million hectares in the EU as a whole, however, and if this area is exceeded, there will be a proportional reduction in the subsidy.

The cultivation of non-food crops for biofuels on set-aside areas, however, can be expected to have specific environmental consequences.
The relevant environmental effects of cultivation on set-aside areas include
- effects on the aquatic environment
- emissions to the air (gaseous emissions)
- effects on biodiversity and natural amenities.

<u>Effects on the aquatic environment</u>
The aquatic environment will be affected by increased leaching of nitrogen, phosphor and pesticides. Although set-aside was not directly included as an instrument under the two Danish Plans for the

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[3] COM(2001) 547, 2001/0265 (COD), p. 26. This assessment is based on detailed studies carried out under the so-called *Autoolie 2* programme.

aquatic environment (*Vandmiljøplan* I and II*)*, it is thought to have played an important role. It is therefore thought that, all else being equal, increased cultivation of set-aside areas would make it more difficult to achieve the nitrogen targets under *Vandmiljøplan* I and II , and make it necessary to increase the reduction targets in *Vandmiljøplan* III. Under the Agreement of 2 April 2004 on *Vandmiljøplan* III 2005-2015 between the government, the Danish People's Party and the Christian Democrats, 50 000 hectares in border strips along watercourses and lakes must be designated before 2015. The border strips will be established by voluntary movement of set-aside to alongside lakes and watercourses. All else being equal, increased use of set-aside land for non-food crops will make it more difficult to establish uncultivated border strips by voluntarily moving set-aside areas.

As pesticides will have to be used for energy crops in the same way on set-aside land as on other land, increased cultivation of e.g. non-food rape on set-aside land will probably make it more difficult to achieve the objectives under the pesticide action plan, including the designation of 25 000 hectares of unsprayed border strips along targeted watercourses and lakes.

Emissions to the air

Cultivating e.g. rape on set-aside land will lead to increased emissions of ammonia and laughing gas due to increased fertilisation and nitrogen leaching. The amount by which emissions will increase depends on the actual soil and climatic conditions, and the size of the area. Increased evaporation of ammonia can lead to increased deposition of nitrogen on otherwise nutrient-poor ecosystems such as bogs and heaths, leading to species being out-competed and thereby reducing biodiversity. Higher emissions of laughing gas will increase greenhouse gas emissions from agriculture, thereby counteracting the $CO_2$ advantages of biofuels.

Effects on biodiversity and natural amenities

A considerable proportion of set-aside land is situated alongside woodland and watercourses, including in and along low-lying and marshy areas such as bogs, meadows and salt meadows. This makes set-aside a valuable tool for protecting flora and fauna, as it adds to the protection of woodland edges and vulnerable natural areas against physical damage, fertilisation and spraying. Natural amenities are also protected.

According to the Nature Report 2002 (*Naturredegørelsen)* and the government's Action Plan for biodiversity and nature conservation 2004-2009 (*Handlingsplan for biologisk mangfoldighed og naturbeskyttelse)*, the government will continue to make use of voluntary, targeted placement of set-aside along high-priority natural areas.

## 1.7. Technical aspects of fuel

The EU Fuels Directive (98/70, amended by Directive 2003/17) regulates a series of properties and contents of individual substances in transport fuels. It is not a complete technical specification, however. In Denmark, the Directive has been implemented by Order No 884 of 3 November 2003 on the quality of petrol, diesel oil and gas oil for use in motor vehicles (the Fuels Order).

In parallel, the European Committee for Standardisation, CEN, has defined the standards EN 228 for petrol and EN 590 for diesel, laying down all the properties relevant to the quality of those fuels. This is an additional, more detailed specification than that in the Fuels Directive or the Danish Fuels

Order. In practice, all petrol and diesel sold in Denmark complies with the CEN standards, which have also been implemented as Danish standards. It is permitted to sell petrol and diesel in Denmark which does not comply with the CEN standards, however, provided that it satisfies the requirements of the Fuels Order.

The current version of the Fuels Directive does not allow requirements to be laid down for the addition of biofuels.
The more expensive fuels will therefore only be added if the government provides sufficient economic incentive, for example more tax rebates for biofuels.
Under the Fuels Directive, before the end of 2005 the Commission must consider the need to encourage the introduction of biofuels and modify the environmental requirements, including solving the problem of vapour pressure when adding ethanol to petrol, see below.

If biofuels were marketed at national level, the most efficient point at which to mix them with fossil fuels would presumably be at the refineries or depots. The Danish Petroleum Industry Association *(Oliebranchens Fællesrepræsentation)* considers that if this approach were to be taken, considerable investments would be required in storage and handling facilities at refineries and depots and to some extent also at petrol stations for ethanol in particular, and to a lesser extent for biodiesel, see also below. Once any necessary investments have been made, no serious handling problems are likely to occur between filling the tanker at the depot and delivery to the petrol station.

To the extent that biofuels are marketed only in limited quantities for local transport over a certain area, the most efficient point at which to mix them with fossil fuels would probably be when filling up at the petrol station.

The Fuels Directive lays down requirements for labelling at the point of sale, if the content of biofuels in petrol and diesel is over 5%. There is uncertainty as to whether higher concentrations would give rise to technical engine problems.

## Bioethanol

Bioethanol as a fuel

Under the EU Fuels Directive and CEN standard EN 228, the maximum amount of ethanol which may be mixed with petrol is 5% (vol.). Petrol mixed with far higher proportions of ethanol may be sold, but in this case no reference may be made to EN 228. Such petrol is usually used in special engines. In Sweden, therefore, there are limited sales of E85 (petrol containing 85% ethanol) for special cars.

As yet there is no CEN standard for E5 (petrol containing 5% ethanol), but the Commission has started a project at CEN with a view to drafting standards *inter alia* for E5.

The Fuels Directive lays down environmentally-based maximum vapour pressure limits for petrol. Changes in the vapour pressure mainly affect the evaporation of petrol and thereby emissions of volatile organic compounds (VOCs) from each vehicle. Adding even small amounts of ethanol will increase the vapour pressure, which makes it impossible to comply with the specified vapour

pressure of 60 kPa for the three summer months. As far as Denmark is concerned, it may be possible to solve the problem for E5 by defining Denmark as a country with severe climatic conditions, as is the case for England, Ireland, Sweden and Finland, where the permitted summer vapour pressure is 70 kPa. It is not certain that the European Commission will agree to this, however.

This solution has an environmental cost, as adding 5% ethanol to all petrol in 2010 is estimated to increase VOC emissions by around 200 tonnes, or 1.5% of the projected total emissions from passenger cars and 0.2% of the projected total emissions of VOCs. The 1990 requirement that new petrol vehicles be fitted with catalytic converters and carbon filters has helped ensure that the figure is no higher. It should be emphasised that the environmental specifications in the Fuels Directive, including the one for vapour pressure, were decided on the basis of a detailed assessment of the most cost-effective means of achieving the agreed air quality standards.

If ethanol is converted to ETBE before being added to petrol, there are no problems in complying with the summer vapour pressure requirements. On the other hand, using ETBE probably involves the same risk of groundwater pollution as the use of the closely related substance MTBE.

From 1 January 2005, EU requirements will reduce the maximum content of aromatics in petrol from 42% to 35%. This will make it more difficult to produce petrol with a sufficiently high octane number.

A relatively cheap substitute for aromatics is MTBE. However, leaks from petrol tanks can lead to MTBE causing groundwater and drinking water to smell.
The Environmental Protection Agency considers that high concentrations of MTBE can pose a health risk. MTBE smells and tastes so strong, however, that it would be smelt or tasted in concentrations far below any harmful level. Taking account of the smell and taste of MTBE therefore also covers the health implications. Due to the risk of groundwater pollution, the oil sector has agreed to add MTBE only to 98 octane petrol sold from specially secure petrol stations (around 1% of petrol sales in 2003), until the end of 2004. The addition of MTBE may be prohibited under the Fuels Directive, if groundwater pollution is or is likely to become a serious problem for human health or the environment. The European Commission has to agree to this, however. MTBE is used in other countries where groundwater does not have the same role in the water supply. MTBE was widely used in Denmark from the 1980s until 2001. Between 2000-2004, the oil sector invested around DKK 0.5 billion in protecting against leaks from the majority of ordinary petrol stations. The remaining (mostly smaller) petrol stations have not yet been secured.

Another possibility is to add up to 5% ethanol to 95 octane petrol (around 80% of petrol sales in 2003). It is not certain, however, that there will be stability of supply for the amounts of ethanol required. Finally, there are other, even less certain alternatives. The addition of MTBE to 98 octane petrol is already necessary at Danish refineries in any case, as the octane number cannot be achieved just by adding the maximum 5% ethanol permitted under the current Fuels Directive. 98 octane petrol is expected to account for a growing proportion of petrol sales in coming years due to the appearance of new, more energy efficient cars on the market.

From the point of view of biofuels, the crucial factor is that the addition of ethanol to 95 octane petrol does not solve the fundamental cost problem of biofuels, as ethanol is far more expensive than MTBE. Adding the permitted 5% bioethanol (vol.) to 95 octane petrol in isolation would represent a total biofuel proportion of 1.4% (by energy content, the measure used in the Biofuels Directive).

Considerations about the risk of MTBE leaching into the groundwater should therefore be decisive in deciding how to solve the problem of ensuring the octane number from 1 January 2005.

Handling bioethanol during storage and distribution
As ethanol is soluble in water, water-free systems are required for storing and distributing petrol/ethanol mixtures or pure ethanol. The Danish Petroleum Industry Association has stated that Danish refineries and storage facilities are not equipped to handle ethanol. The storage facilities do not have sufficient tanks available to store ethanol and petrol separately for subsequent mixing. The Petroleum Industry Association considers that it will be necessary to invest DKK 200-300 million in new tanks and mixing facilities at import storage installations and refineries.

Problems such as the corrosion of certain tanks and plastic hoses may occur in connection with distribution. It has not yet been possible to assess the extent of these problems in any detail. Solutions have, however, been found in countries which already market petrol containing ethanol. It has not been possible either to shed any light on problems which may occur with observing the emergency stocks required by law, if they include petrol/ethanol mixtures.

### Biodiesel

The most common form of biodiesel in Europe is RME (rapeseed oil methyl ester). The European standard EN 590 allows up to 5% (vol.) RME in diesel. This is equivalent to 4.6% of energy content. As mentioned above, diesel containing a far higher proportion of biodiesel may be sold in Denmark, provided that it complies with the provisions of the Fuels Order. In this case, however, the consumer cannot be sure that the manufacturer's guarantees for the vehicle will continue to apply.

Handling biodiesel during storage and distribution
Pure biodiesel or diesel containing biodiesel is more perishable than diesel, for which reason a faster turnover is required for biodiesel products. Other than this there are no particular storage problems, but the Petroleum Industry Association considers that new storage tanks and delivery facilities would be required at refineries and depots if it were to become widely used.

## 2. Current efforts to utilize biomass for energy in Denmark

Until now, efforts to promote the use of biofuels for transport in Denmark have taken the form of research into means of reducing the additional costs they entail in relation to fossil fuels. At present, Denmark produces a certain amount of biofuels for export, but uses very little of them itself.

In contrast, a considerable amount of biomass is used to produce electricity and heat. The Biofuels Directive points out that the amount of national resources used to produce biomass for energy use other than transport may explain why the national indicative target for the use of biofuels deviates from the reverence value.

## 2.1. The use of biomass for energy production in general

The use of biomass for energy production in Denmark almost tripled between 1980-2002 as a result of Danish energy and taxation policies, as shown in Table 2. A series of government-financed aid schemes, together with rising taxes on fossil fuels such as coal, oil and natural gas, have made biomass more and more attractive. Depending on the fuel it is replacing, the use of biomass for heat production is largely exempt from taxes, indirectly subsidising its use.

In 2002 the total use of biomass was approx. 85 PJ from around 3 million tonnes of waste (80% of which was actual biomass), 1.1 tonnes of straw, 0.3 million tonnes of woodchips, 0.7 million tonnes of wood residue, 0.4 million tonnes of wood pellets and 0.8 million tonnes of firewood.

**Table 2. Use of biomass for energy 1980-2002**

| **PJ** | **1980** | **1990** | **1995** | **2000** | **2001** | **2002** |
|---|---|---|---|---|---|---|
| **Biofuel** | | | | | | |
| - straw | 7,1 | 14,2 | 13,1 | 12,2 | 13,7 | 15,7 |
| - woodchips | 0,2 | 1,9 | 2,3 | 3,0 | 3,5 | 4,1 |
| - wood residue | 3,8 | 6,2 | 5,7 | 6,9 | 8,6 | 10,4 |
| - wood pellets | 0,1 | 1,7 | 2,4 | 5,1 | 6,5 | 7,0 |
| - biogas | 0,2 | 0,7 | 1,7 | 2,9 | 3,0 | 3,4 |
| - firewood | 7,6 | 8,8 | 11,5 | 11,7 | 11,9 | 11,3 |
| - waste | 10,6 | 15,2 | 21,6 | 30,5 | 32,4 | 33,5 |
| **Total biomass** | **29,6** | **48,8** | **58,2** | **72,4** | **79,7** | **85,4** |
| **of which used in** | | | | | | |
| - electricity and heat production | 13,3 | 25,2 | 33,5 | 45,9 | 49,9 | 53,9 |
| - other industries | 5,9 | 9,6 | 8,9 | 9,5 | 11,6 | 13,8 |
| - domestic use | 10,4 | 14,0 | 15,8 | 17,0 | 18,2 | 17,7 |

NB: around 80% of waste is actually biomass

Source: Danish Energy Agency, Energy Statistics 2002.

In addition to a series of subsidies and tax differentials, the so-called biomass agreement of 1993 has been an important factor in the increased use of biomass resources. A large majority in the *Folketing* required electricity plants to use 1.4 million tonnes of biomass in power stations before the end of 2000. The decision was taken partly for environmental reasons, and partly for other reasons such as resource management, consideration for agriculture and forestry and the economy of and employment in local communities.

The full implementation of the biomass agreement has been postponed until 2005, however, so Table 2 cannot show its full effect on the use of biomass. In 2005, plants owned by electricity stations will use almost 20 PJ biomass, as opposed to around 10 PJ in 2002. By way of comparison, it is estimated that the reference targets in the Biofuels Directive of 2% biofuel use in 2005 correspond to 3.4 PJ in 2005: see Table 1. The reference target of 5.75% in 2010 is estimated to correspond to 10.4 PJ.

In accordance with the political agreement of 29 March 2004, the government has secured continued support for new biogas plants for decentralised combined heat and power production, up to an overall ceiling of 8 PJ for existing and new biogas plants connected to the network before the end of 2008. This is equivalent to doubling the current capacity.

By virtue of its targeted policy, therefore, Denmark has already increased the total use of biomass in energy production by far more than the limited recommendation for the transport sector in the Biofuels Directive.
It was previously thought that the most cost-effective means of using the energy content of biomass in Denmark was for electricity and heat production.

Table 3 shows that with a proportion of biomass (excluding waste) of 5.1% in 2001, Denmark was the EU Member State with the fifth largest use of biomass, relatively speaking. The use of biomass in Denmark was also well above the EU average, despite the fact that, as mentioned above, the biomass action plan had not been fully implemented. In countries with far more favourable natural conditions, however, biomass plays an even greater role in energy production. This applies to countries with extensive forest resources such as Finland, Sweden and Austria.

**Table 3. Biomass: proportion of total energy consumption in 2001 in EU-15, %**

| BE | **DK** | DE | GR | ES | FR | IE | IT | LU | NL | AT | PT | FI | SE | UK | **EU** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0,6 | **5,1** | 1,5 | 3,4 | 3,0 | 3,7 | 1,3 | 3,2 | 0,5 | 0,6 | 9,5 | 7,8 | 19,1 | 14,9 | 0,8 | **3,2** |

NB: the figures exclude waste.
Source: information from Eurostat.

## 2.2. The production and use of biofuels

Denmark produces 40-45 000 tonnes of biodiesel (RME). This production is exported. An area of 20-25 000 ha is used for energy crops, almost exclusively rape for producing biodiesel.

The Danish consumption of biofuels for transport is very low and limited to experiments at local level.

On a global scale, the US and Brazil are by far the largest producers of biofuels. In the US, ethanol, which is usually produced from maize, accounts for around 1% of petrol consumption. In Brazil, ethanol is produced from sugar cane.

In EU-15, more biodiesel is produced than bioethanol, apart from in Spain and Sweden, see Table 4. In EU-15 ethanol is usually produced from sugar beet, wheat and barley, whereas biodiesel is usually produced from rapeseed and sunflower seed.

**Table 4. Production of bioethanol and biodiesel in EU-15 in 2002**

| Tonnes | Bioethanol | Biodiesel |
|---|---|---|
| Spain | 176.700 | 6.000 |
| France | 90.500 | 350.000 |
| Sweden | 50.000 | 10.000 |
| Germany | | 550.000 |
| Italy | | 220.000 |
| Austria | | 30.000 |
| Denmark | | 40.000 |
| **Total** | **317.200** | **1.206.000** |

NB: in Spain and France ethanol is mainly converted into ETBE.
Source: *htpp://www.energies-renouvelables.org*. Own information for Denmark, however. In 2003 Denmark produced 45 000 tonnes of biodiesel (RME) most of which was exported to Germany, where there were tax advantages for biodiesel.

In terms of energy units, the production of biofuels in EU-15 rose by 39% from around 0.9 million tonnes oil equivalent in 2001 to around 1.3 million tonnes oil equivalent in 2002, or 0.6% of the total consumption of petrol and diesel for transport.
For EU-15, a proportion of biofuels of 5.75% in 2010 is estimated to correspond to 17.5 million tonnes oil equivalent. It is still difficult to gain an overview of the biofuel policies planned in all the other EU countries.

## 2.3. Research into biofuels

In Denmark, a considerable amount of research has been carried out in recent years into new methods of producing biofuels. Particular emphasis has been placed on developing processes to make use of organic residues and waste from agriculture, forestry and the timber industry, etc. (such as straw and wood) to produce bioethanol. These "low value" products are harder to convert to ethanol than "high value" crops such as sugar, corn and maize, which are traditionally used, but on the other hand they are cheaper and do not displace the production of food crops on agricultural land. At present, production is only taking place on an experimental basis in Denmark.

The outlook for this research is that, given a sufficient reduction in the cost of production, it will be possible to produce bioethanol far more cheaply and in larger quantities because of the availability of cheap raw materials. The Danish Energy Agency considers that research in this field has the greatest potential for achieving both financially and environmentally sustainable biofuel production under Danish conditions or with Danish involvement.

Until now, the Energy Agency, through the Energy Research Programme, has supported this research at the Technical University of Denmark, Risø National Laboratory and Novozymes. Support has also been provided by the Ministry of Science, Technology and Innovation. Research has taken the latest technologies to a certain point, but it will now be necessary to demonstrate the processes in pilot and demonstration plants, and continue the development with a view to reducing production costs in a targeted manner. The aim is to bring the costs closer to the prices of fossil fuels.

The EU provides half the costs of an extensive project currently being carried out by Elsam totalling around DKK 100 million, the main objective of which is to reduce the cost of producing electricity and bioethanol from straw and household waste.

A considerable amount of public funding is available for developing new energy technologies in Denmark, and will continue to be available in coming years. Projects involving biofuel technologies will be considered provided that they satisfy the requirements for quality of research, social relevance and co-financing from industry. The Danish Energy Agency has started work on a Danish strategy for further research into and development of biofuel technologies.

## 3. Socio-economic costs of using biofuel for transport

The socio-economic costs of using biofuels for transport largely depend on the production costs of biofuels in relation to the prices of the fossil fuels they are replacing. Biofuel production costs vary with the highly variable prices of the raw materials (rapeseed, sugar, wheat, etc.), just as fossil fuel prices vary with the highly variable price of crude oil. Exchange rate fluctuations also play a role.

Consequently there is no simple correlation between a particular measure to stimulate demand in Denmark and the actual demand which results. The effect on Danish demand of *a particular Danish tax differential* in favour of biofuels therefore depends on current and projected additional prices for biofuels on highly variable markets. A further factor is that tax differentials in other countries also affect the outcome, as the supply will go to the place where the tax advantages are greatest, i.e. where the producer can get the highest price. The total supply is limited both in the short term by production capacity and in the long term by the availability of agricultural land, so "competitive tax rebates" will cause the prices of biofuels to rise so much that demand from less attractive areas will cease.

The ability of Danish producers to meet a *particular Danish demand* for biofuels depends on their competitiveness on the international market.

The current trend, whereby biodiesel produced in Denmark is exclusively exported to countries with tax systems which favour biofuels, cf. section 2.2, is evidence of this.

The extremely tenuous link between Danish policies and the resulting production in Denmark means that any socio-economic assessment is very complicated.[4] In the following, for the sake of simplicity, it has been assumed that a particular Danish demand can be met by Danish production.

In global terms, the cheapest biofuel is bioethanol produced in Brazil, where the production costs are around half those in the EU. At present, most of the price difference is neutralised at the EU's borders where duty of €0.102 (DKK 0.76) is imposed per litre of pure bioethanol imported into the EU. For petrol mixed with up to 30% bioethanol and for most biofuels (pure or mixed), the rates of

[4] The extent to which the production is Danish affects the extent to which the environmental consequences of producing the biofuels will be felt in Denmark. This applies, for example, to emissions of greenhouse gases during production and the (unquantified) environmental effects of cultivating energy crops.

duty for import into the EU are generally very low (around 5%) or zero. If there were a market for it, more countries could probably produce biofuel relatively cheaply. The new EU Member States will presumably have potential for gaining market share in EU-15. A certain amount of imports from the new Member States may also be needed, if all the EU-15 are to achieve the EU's reference targets.

It is thought that the cheapest Danish-produced biofuel is currently biodiesel (RME), for which Denmark has a relatively large production capacity.

In connection with the government's climate strategy, the Danish Energy Agency has estimated the socio-economic costs of encouraging demand for biodiesel in Denmark by means of tax rebates.[5] The core estimate is that the socio-economic cost of producing biodiesel is almost 1½ times higher than that of fossil diesel (measured in energy units). The figures do not include the additional costs for handling biodiesel during storage and mixing. The cost of reducing $CO_2$ is thought to be over DKK 400 per tonne $CO_2$. Although this figure does not include the positive effects of security of supply and technological development, it also excludes certain negative environmental effects of cultivating energy crops on set-aside land. If energy crops are cultivated on areas in rotation instead, the net result is unlikely to be negative for the environment.
It is thought that sufficient biodiesel can be produced to remove 480 000 tonnes of $CO_2$ per year, accounting for 85% of the reference target for 2010 of 5.75% biofuel, with maximum use of set-aside land where the set-aside rate is 10.

The result far exceeds the indicative figure in the government's climate strategy of DKK 120/tonne $CO_2$ for cost-effective action against climate change.[6] The Danish Energy Agency's estimate of the costs of biodiesel are low in relation to international estimates. Though the difference is less than considerable, the reason for it is unclear. It may be due to the fact that the Danish costs have been calculated for a relatively large production plant, which may benefit from economies of scale.[7] In contrast, as explained in section 4.1, a far higher tax rebate for biodiesel appears to be necessary than that indicated by the Energy Agency's calculations, suggesting that the additional cost of biodiesel has been underestimated.

In 2001, the European Commission calculated that biodiesel was more than twice as expensive to produce as ordinary fossil diesel.[8] The Commission estimated the cost of reducing $CO_2$ using biofuels to be €100-150/tonne $CO_2$ (around DKK 750-1125/tonne $CO_2$), which is above the limit for cost-effective measures to meet the EU's commitment for the first Kyoto period (2008-2012).

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[5] Updated documentation of the calculations for biodiesel can be found in the DEA's Documentation for calculating the costs of reducing $CO_2$ using biodiesel – revised version, December 2003 (in Danish).

[6] Danish government, Presentation of a climate strategy for Denmark, February 2003 (in Danish).

[7] The calculations are based on information from Emmelev A/S on production costs at the factory, etc. The Danish Energy Agency did not question the accuracy of this information.

[8] COM(2001) 547, 2001/0265 (COD), pp. 23-24.

Studies carried out by the International Energy Agency (IEA) have also concluded that the production costs of bioethanol and biodiesel are currently two to three times higher than the cost of petrol and diesel respectively. It seems unlikely that the cost of reducing $CO_2$ using "conventional" biofuels will fall much below USD 100/tonne $CO_2$ (around DKK 600/tonne $CO_2$ at the current, low exchange rate).[9]

In conclusion, the socio-economic costs of encouraging the use of biofuels are very uncertain, but there is no doubt that given the current state of crude oil prices, biofuels are far more expensive than fossil fuels.
This is reflected by the fact that any desire to stimulate the demand for biofuels to a significant extent will have to be accompanied by considerable subsidies for their use. Germany has therefore fully exempted both pure and mixed biofuels from tax from 1 January 2004. The tax exemption corresponds to €0.47 (around DKK 3.5) per litre for biofuel replacing fossil diesel, and €0.65 (around DKK 4.8) per litre for biofuel replacing petrol.

## 4. Options for promoting the use of biofuels

The fundamental problem with the Biofuels Directive is that it uses quantitative targets, although it is not possible to predict with any accuracy the quantitative effect of measures which depend on market forces such as general tax differentials.

Demand can be stimulated in various ways in order to meet a particular target for the consumption of biofuels:
- national tax differentials in favour of biofuels,
- use for transport over a limited area, possibly with local tax differentials.

Whatever the option chosen, in the end, the additional costs of using biofuels in Denmark will have to be paid for by Danish citizens. The final option chosen – for a given level of ambition – will mainly affect the distribution of this burden, but may also affect the total additional costs, as some solutions are more effective than others.

### 4.1. National tax differentials in favour of biofuels

As mentioned above, it is not possible to predict the full effect of a particular tax differential on consumption, and the effect will also vary over time depending on market conditions. The Energy Taxation Directive also requires tax rebates to be adjusted in line with developments in the prices of raw materials so they do not over-compensate for the additional costs of products. Ideally, this would involve frequent adjustments to tax differentials.

Biofuels usually have a lower energy content per litre than the mineral fuels they replace. In accordance with EU requirements, the rates of tax on fuel apply per litre. At present, therefore, biofuels are more heavily taxed per energy unit (or per kilometre driven) than equivalent mineral fuels. As long as biofuels are added to mineral fuels in small quantities, however, the effect of this is

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[9] IEA, *Prospects for Biofuels, Results to Date from the IEA's Transport Biofuels Project*, 13. maj 2003. The main potential for reducing costs is thought to lie in producing ethanol from cheaper cellulosic materials, cf. section 2.3.

minimal, and the problem is just another aspect of the fact that the energy content of a litre of fuel depends on its precise specification. For example, "petrol" is the term used for a category of hydrocarbons, the precise composition and thereby energy content per litre of which depends on the additives used, the environmental requirements, etc. For practical reasons, therefore, it is neither desirable nor possible to design the energy tax on petrol in such a way that the rate is the same per energy unit for all current and potential future concrete specifications of the product.

To the extent that a market emerges for the addition of higher concentrations of certain biofuels, the rates of tax could be adjusted at that time to take account of widely differing energy contents per litre.

The $CO_2$ tax on diesel is currently DKK 0.27 per litre used as motor fuel. This is in addition to the energy tax of DKK 2.48 per litre, making a total of DKK 2.75 per litre low-sulphur diesel.
The *Folketing* has agreed to reduce the $CO_2$ tax on diesel to DKK 0.243 per litre from 1 January 2005 while raising the energy tax by a similar amount, so the overall tax rate remains unchanged, see Table 5.
Petrol is subject only to an energy tax of DKK 4.04 per litre.

**Table 5. Taxes on mineral motor fuels, 1 January 2005.**

| DKK per litre | **Unleaded petrol** | **Low-sulphur diesel oil** |
|---|---|---|
| Energy tax | 4,04 | 2,507 |
| $CO_2$ tax | | 0,243 |
| Total | 4,04 | 2,750 |

NB: The new $CO_2$ tax on diesel corresponds to DKK 90/tonne $CO_2$, and is the real basis for the $CO_2$ taxes imposed on industry.
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The new $CO_2$ tax on diesel corresponds to around DKK 90/tonne $CO_2$ emitted during combustion. The level of this tax is determined by other $CO_2$ taxes and is also in line with the indicative figure for climate-policy measures in the government's climate strategy.[10]

As biodiesel and other biofuels which directly replace fossil diesel are virtually $CO_2$ neutral, removing the associated $CO_2$ taxes would improve the climate policy cost efficiency.[11]

In the case of petrol, DKK 90/tonne $CO_2$ corresponds to DKK 0.21/litre petrol. An energy tax of DKK 4.04/litre petrol can therefore be divided into a $CO_2$ tax of DKK 0.21/litre and an energy tax of DKK 3.83/litre, keeping the total tax on petrol at the same level. The $CO_2$ tax can thus be removed for biofuels added to or replacing petrol.

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[10] The indicative figure of DKK 120/tonne $CO_2$ is based on a projected maximum price of $CO_2$ emission allowances on the future market of around DKK 100/tonne $CO_2$ multiplied by a so-called net tax factor of 1.17. The estimated average price of $CO_2$ allowances is around DKK 50/tonne.

[11] Greenhouse gases are emitted during biofuel production. They are not therefore 100% $CO_2$ neutral.

In a cost-effective environmental policy, any further tax reductions should focus on arguments for using biofuels other than the $CO_2$ benefit.
The amount of weight to be given to such non-quantifiable advantages is basically a political decision.

The tax rebate required to meet the EU reference target of 2% for 2005 is difficult to determine and varies over time, as it depends on expectations of highly variable market conditions. For example, over the last six years, the annual average price of petrol and diesel excluding taxes has varied by around DKK 1/litre. The monthly average has varied even more. When this is added to variations in the price of the raw materials for biofuels, based on recent price trends, the tax rebates required to offset the higher cost of producing biofuels could vary by up to DKK 2/litre over six years. The situation is further complicated by the fact that the tax rebates required to achieve a specific target also depend on tax rebates abroad.

Biodiesel for heating is currently exempt from taxes and in many cases can replace heating oil, which is taxed at DKK 2.10/litre. Not much biodiesel is used for heating, however, suggesting that the tax differential must be greater than DKK 2.10/litre to have a significant effect on demand. However, this may be due to problems with ensuring a sufficiently rapid turnover when biodiesel (which is more perishable) is stored in private oil tanks.

Under current market conditions, the tax rebate necessary to promote biofuels for transport is likely to represent a large part of the total tax of DKK 2.75/litre on biodiesel, as well as a large part of the total tax of DKK 4.04/litre on bioethanol, not least in the light of the even higher, "competing" tax rebates in Germany.

For a target figure of for example 2%, it would be useful to grant a particular tax rebate per litre of diesel or petrol mixed with at least 2% biofuel (by energy content).
This would make it unprofitable to add more than 2% of the more expensive biofuels. If this should nevertheless be done, taken in isolation it would limit the loss of revenue to the State, as the tax is charged per litre fuel, and as mentioned above, more than 1 litre of biofuel is required to replace 1 litre of mineral fuel. Fully exempting the 2% biofuel in the mixture from tax corresponds to a tax reduction of DKK 0.05-6 per litre diesel containing at least 2% biodiesel. A corresponding tax reduction for other mixtures of biofuels and mineral fuels (by energy content) would take the immediate loss of State revenue up to around DKK 250 million/yr. This is in addition to the costs of financing the measures. If a tax rebate is granted in 2010 to mixtures containing at least 5.75% biofuel with a view to meeting the reference target of 5.75%, and if biofuels do not become much cheaper in relative terms, the rebate rises to DKK 0.16 for mixtures of diesel and biodiesel. A corresponding tax reduction for other mixtures of biofuels and mineral fuels would take the immediate loss of State revenue up to around DKK 0.8 million/yr. This is, however, conditional upon the tax rebates resulting in the specified level of biofuel consumption, which cannot be taken for granted, as mentioned above.

## 4.2. Use for transport over a limited area, possibly with local tax differentials

The use of biofuels can be restricted to certain transport fleets. As mentioned above, the Energy Taxation Directive also provides for limited tax rebates or exemptions for the use of biofuels for public transport, etc. To a large extent, however, this sector already benefits from tax rebates or exemptions. If tax rebates are unable to make the price of biofuels sufficiently attractive, direct State subsidies can be used.

Using biofuels in vehicles serving a clearly defined area is the best approach if a limited effect, and thereby a lower subsidy, is desired. This naturally does not reduce the additional costs per unit of biofuels.

The main disadvantage in the short term is that many otherwise suitable areas are already covered by agreements and contracts between transport operators and private companies, etc., so it is not easy to influence the choice of fuel. The contracts are usually for several years. Forcing a change of contract during the contract period would cause various problems. Amongst other things, the company which initially failed to win the contract could claim that the terms have changed, and that they would be cheapest under the new terms, leading to a possible claim for compensation. In the longer term, it will be easier to influence the choice of fuel in connection with the conclusion of new agreements and contracts, provided that the State offers the necessary financial incentives.

Table 6 show that certain delimited areas account for almost 5% of the total fuel consumption for transport; these areas could be made the focus of targeted policies to promote the use of biofuels. The potential to use biofuels in these areas varies considerably, but is not well known. Biofuels are not therefore of equal relevance to all the areas mentioned. The proportion of biofuel which can be used without considerable additional costs being incurred to modify engines, or for storage and blending, varies from area to area. Special studies would be required to map these differences.

One of the most suitable areas is public transport by bus, which accounts for at least 2% of the total fuel consumption for transport. Here, fossil diesel can probably be mixed with more than 5% biodiesel (RME) in many cases, without technical problems or the associated costs of modifying engines. Moreover, new buses, which will probably be no more expensive to purchase, will be able to run on mixtures containing a large proportion of biodiesel, providing a route for phasing in biodiesel. Local buses in particular areas of several other EU countries run on diesel mixed with e.g. 30% biodiesel, or entirely on biodiesel. Other biofuels are used in like manner, in high concentrations. As mentioned above, however, determining the precise potential for the use of biofuels in this field will require a more detailed study of *inter alia* any possible technical problems

**Table 6. Fuel consumption in selected important delimited transport areas in 2002**

| **Areas** | **Consumption of diesel** | **Proportion of total energy consumption for transport in PJ** |
|---|---|---|
| | ----------Million litres---------- | ---------%--------- |
| Danish State Railways (DSB) | 64 | 1,4 |

| | | |
|---|---|---|
| The Greater Copenhagen Authority (HUR)* | 40 | 0,9 |
| 17 other county/municipal transport companies* | 55 | 1,2 |
| Taxis | 45 | 1,0 |
| The Armed Forces | 12 | 0,3 |
| **Total for areas examined** | **216** | **4,8** |

* Estimate based on bus operating hours
NB: biofuels are not of equal relevance to all the areas mentioned.

If biofuels are only used locally, the users themselves will probably be left to solve the problems of storage and any mixing. For example, a bus company may have its own tanks of fossil diesel and biodiesel, which are mixed when the vehicle is refuelled. In this case, the company itself would have to invest in additional tanks and mixing equipment. This suggests that biofuels are best used in densely populated areas where there is a relatively large consumption within a limited area. The use of biofuels in buses operating in rural areas and small provincial towns, and taxies, is therefore likely to be relatively expensive.

The technical aspects of biofuel use in the fields of rail and maritime transport are not as clear, nor as tried and tested abroad.

The State can also lay down requirements for the use of biofuels in its own vehicles, for example in the armed forces. This in itself does not reduce the costs to the State of encouraging the consumption of a specific proportion of biofuels.