

What part can renewable fuels play in reducing the transport sector's impact on climate change?

Conclusions from the Committee on Transport and Communication's Research Review 2007/08:RFRI 4



In the spring of 2008, the parliamentary Committee on Transport and Communications commissioned a review of current research in the field of renewable fuels, and their role in reducing the transport sector's impact on climate change. The review was conducted by Jonas Åkerman of the Royal Institute of Technology in Sweden and Max Åhman of the Faculty of Engineering at Lund University. It has been published as part of the Riksdag Research Reports (RFR) series. A brief summary follows below.

Climate change – one of our greatest challenges

Limiting the emission of greenhouse gases into the atmosphere represents one of the greatest challenges of our time. There is increasing agreement among the research community that emissions of carbon dioxide and other greenhouse gases contribute to climate change. The transport sector is responsible for a large proportion of such emissions. The road sector alone is responsible for 30 % of society's total emissions. One way of meeting the climate objectives that have been set – both in Sweden and internationally – is to replace fossil fuels with renewable fuels. It is important to identify which fuels and production methods are acceptable in terms of the environment, resources and the economy.

Many factors influence access to bioenergy

There exists a conflict of interests as regards use of land area, and this conflict affects the amount of bioenergy that can be produced. Land is required for production of food and timber, but also to guarantee biological diversity and ecosystem services. The amount of bioenergy that can be used for transport also depends on demand for bioenergy outside the transport sector. Bioenergy is most efficiently used for combined electricity and heat production, either in industrial processes or in thermal power stations.

Definitions

Two-degree target

The EU and Sweden have set as a target that mean global temperatures may not be permitted to rise by more than two degrees in relation to pre-industrial levels. To achieve this target, industrialised countries must reduce their greenhouse gas emissions by 80-90% by 2050.

Renewable fuels

These are fuels produced from renewable energy sources, such as biofuels from biomass. Other examples are electricity produced from biomass, wind, sun, geothermics or waves.

Non-renewable fuels

An example of non-renewable fuels is fossil fuels.

First and second generation biofuels

First generation fuels such as ethanol and biodiesel are available today and are produced from agricultural produce including wheat, sugar, maize and rape. Second generation fuels are still under development and are produced from raw wood materials, e.g. from forest waste or energy forest plantations. Examples of such

fuels are methanol, DME and biomethane.

Ecosystem services

Ecosystem services can be defined as products and services deriving from nature and of benefit to humans – such as pollination, food, water, timber and opportunities for recreation.

Energy carriers

An energy carrier can be a substance or system that stores and/or transports energy, such as electricity and hydrogen. An energy carrier is, in other words, not in itself a source of energy.

Land-use efficient fuels

Fuels are land-use efficient when a large amount of energy can be obtained per cultivated land area.

Co-generation

A process for the production of fuels, electricity and heat etc. from biomass.

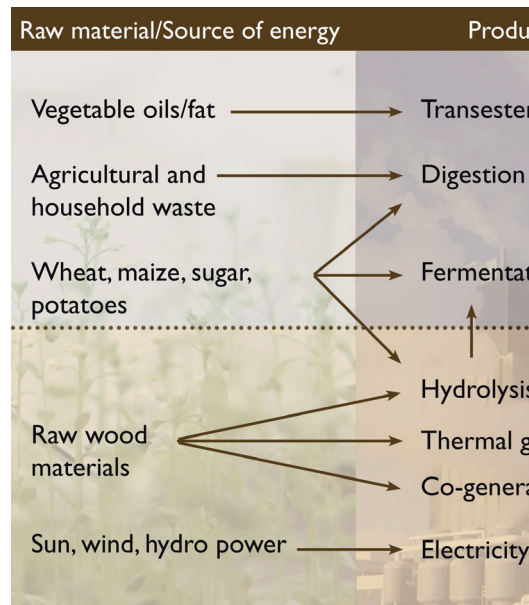
Transesterification

Hydrocarbons that are obtained from gasification of biomass can be converted to biodiesel by means of a process known as transesterification.

Biofuels are only sufficient for a limited part of the transport sector's energy needs

Biodiesel and ethanol produced from rape, wheat or maize are not sustainable in the long term, in terms of resources, the economy or their climate impact. Ethanol from sugar does, however, have the potential, also in the future, to play a role for global energy supplies, even if it cannot replace more than a small part of the world's total fuel use. A condition is that it can be produced without any negative consequences for our valuable ecosystems – and for rain forest areas in particular. Biomethane (biogas) from digestion, for example of waste or sludge, often has positive environmental effects. Again, biomethane can only provide for a smaller proportion of the transport sector's energy needs, but it can play an important role as a niche fuel, for example, for city buses.

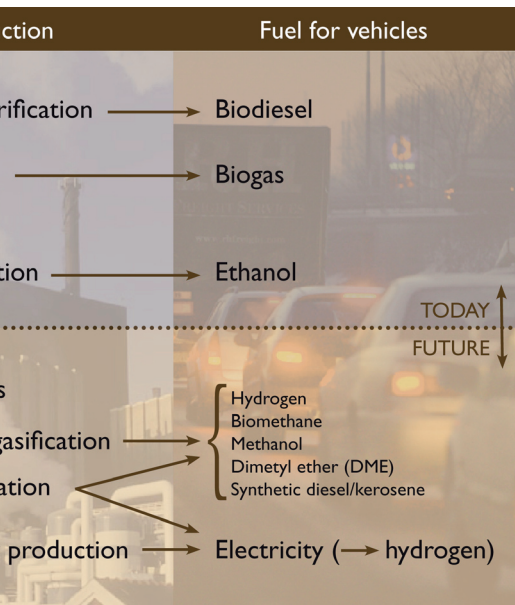
Not all biofuels that are produced today are effective. But they can still – at least in the medium term – make a positive contribution to the transformation of the energy supply system. Above all they can give us useful experience for the development of second generation fuels.



Future biofuels from raw wood materials

Second generation fuels are produced from wood products by means of gasification or by enzymatic hydrolysis. These wood products may come from forests, energy forest plantations or agricultural waste. Second generation biofuels give low emissions of greenhouse gases over their entire lifecycle. Compared with today's biofuels, they are also more efficient in terms of land-use. Raw wood materials can provide many forms of fuel (see figure).

If gasification technologies become established, methanol, DME and biomethane can become energy-efficient and manageable forms of biofuel. DME is an interesting alternative, primarily for use in heavy vehicles. But ethanol can also become an energy-efficient alternative if enzymatic hydrolysis of raw wood materials achieves a breakthrough.



The main methods of converting raw materials to fuel for vehicles for the most topical fuels

Electric power – an important contribution to energy efficiency and reduced emissions

Electric power gives high energy efficiency in vehicles, combined with low emissions, but only if the electricity is produced from renewable/carbon dioxide-neutral energy sources. Increased use of electric power – both in the form of plug-in hybrid vehicles and rail transport – is therefore an important component in achieving the two-degree temperature target. Today there are no plug-in hybrids on the market, but they will be introduced in the next few years – provided we see advancements in battery technologies. Since it is calculated that plug-in hybrids will be more expensive than other cars, sales will presumably be limited to start with. But in the long-term, by about 2050, it is possible that almost 50 per cent of all car travel will take place using electricity from the grid.

Hydrogen and fuel cells – perhaps in the long term

Hydrogen can be produced in various ways, including from biomass, for use in fuel cells. But there are currently major technical and economic problems associated with the distribution and storage of hydrogen. Furthermore, hydrogen based on biomass only has a marginally higher efficiency in comparison, for example, to DME – taking into account its entire lifecycle. If hydrogen is to achieve a breakthrough, a probable prerequisite is good access to relatively cheap electricity. This could be possible if, in turn, solar-cell electricity has a breakthrough.

CONCLUSIONS

- In order to achieve the two-degree target, we need **more efficient technologies, carbon dioxide-neutral energy** and an end to the current rapid **increase in road transport and air travel**.
- **Biofuels** are only sufficient for a limited part of the transport sector's energy needs.
- Electric power in the form of **plug-in hybrid vehicles** and **rail traffic** can, in the long term contribute substantially to better energy efficiency and reduced emissions.
- In the long term, today's **biodiesel from oil-producing plants** and **ethanol from wheat/maize** are not sustainable in terms of resources, the economy or from a climate perspective.
- **Future biofuels** – second generation fuels – that are based on raw wood materials potentially have very low lifecycle emissions of greenhouse gases and are efficient in terms of land-use.
- The future as regards the development of **hydrogen and fuel cells** is currently unclear but, under certain circumstances, they may play a significant role in the long term.



A combination of measures

To be able to reduce emissions of greenhouse gases by 2050, a combination of measures in three key areas are needed:

- Much more efficient technologies in all sectors of society
- A significant rise in the production and use of carbon dioxide-neutral energy
- A stop to the rapid increase in the volume of air travel, road transport and other resource-intensive consumption.

Furthermore, rail traffic, improved freight transport logistics, accessibility via IT and transport-saving urban planning are recommended.

For further information please contact:

The Committee on Transport and Communications
Sveriges riksdag
SE-100 12 Stockholm
Sweden
Tel: +46-8-786 40 00