Flying green

Potentials, Risks and Perspectives of Agrofuels in the Aviation Sector

International climate policies are aimed at keeping global warming below two degrees Celsius until the end of the 21st century, as compared to pre-industrial times. In order to achieve this goal, there is a need for a timely implementation of effective mitigation measures to prevent climate change. Therefore, the aviation sector, like other industries, must make increasing efforts to address the challenges of climate change and diminishing oil reserves. This is even more important given its expected strong quantitative growth. The International Civil Aviation Organization (ICAO) expects global aviation to grow by 4.9 percent annually between 2010 and 2030 (ICAO 2013). The sector has therefore defined ambitious targets for itself. From 2020 onwards, international aviation should grow in a CO_2 neutral manner. Net CO_2 emissions are to be cut by half by 2050, as compared to 2005. Using agrofuels is regarded as a possibility to reduce greenhouse gas emissions and the negative impacts of air travel.

Not only the ICAO, but also the European Union, the International Air Transport Association (IATA), and national associations have formulated climate-related mitigation targets. In all these initiatives, agrofuels play a decisive role. Therefore, there is a need for an intensive debate about the potentials and risks involved in the use of agrofuels, and for exact information about the conditions under which they are being produced. Furthermore, a careful examination is needed to find out whether it is possible to produce enough biomass for the production of agrofuels without compromising food production and increasing hunger and poverty. In this context, we especially need to look at potentials to increase the yields of agrofuel crops and to utilise degraded soil. Only in this way can we assess the feasibility of agrofuel projects, the actual reduction of greenhouse gas emissions, and the human rights, social, and ecological impacts.

1 — Further information in Brot für die Welt 2014: Aviation in times of Climate Change. Agrofuels - boon or bane for future mobility?

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Brot für die Welt

Bread for the World – Protestant Development Service

Ambitions to Decarbonise Aviation

- European Union (White Paper 2011):
  - 60% cut in green house gas emissions by 2050, as compared to 1990
  - Increase the share of sustainably produced low carbon fuels in aviation to 40% by 2050
- EU Advanced Biofuels Flight Path:
  - From 2020, annual use of two million tons of sustainably produced agrofuels in European aviation
- International Air Transport Association (IATA):
  - Increase fuel efficiency by 1.5% per year between 2009 and 2020
  - CO_2 neutral growth of the aviation sector from 2020
  - Cut CO_2 emissions by 50% by 2050, as compared to 2005
  - Further promotion of agrofuels in aviation, but without a concrete quantitative target
- Aviation Initiative for Renewable Energy in Germany e.V. (aireg):
  - Aviation fuels in Germany to contain a blend of 10% biofuels by 2025

Agrofuels for Aviation in Practice

As a substitute for kerosene-based aviation fuel, the only alternatives currently in use are hydro treated vegetable oils/hydro processed esters and fatty acids (HVO/HEFA). Palm oil is currently the most important feedstock, mainly because of its low price, but rapeseed, soybean, and jatropha oils also serve the production of HVO. They are currently particularly used in road transport as diesel substitutes. In the aviation sector, agrofuels have so far only been used in small quantities. In 2009, a passenger aircraft of the Dutch carrier KLM was the first one to use a blend of 50% aviation agrofuels. In 2013, a 26 weeks' test phase followed, during which a weekly flight from New York to Amsterdam was powered with a 50% blend of aviation agrofuels based on used cooking oil and camelina sativa oil. In 2011, Deutsche Lufthansa AG also tested an aviation agrofuel blend of camelina, jatropha and animal fats for five months between Hamburg and Frankfurt.

In the future, biomass from wood, stalks, residues and waste materials is to be used for the production of substitutes for kerosene-based aviation fuels. However, in each individual case it must be checked to what extent the necessary resources are actually available (DBFZ 2014). At this point of time, the availability of this generation of fuels is not predictable, for both economic and technical reasons. Most of the studies available assume that because of their high biomass potential for agrofuels, oil-rich energy plants will continue to be used (DBFZ 2014). Worldwide, these crops are grown particularly for this purpose and often have negative human rights, ecological, and social impacts.

Potentials of Agrofuel Production

The biomass potential from agriculture and forestry, residues and waste is limited. Statements about its availability involve many uncertainties, as the underlying assumptions in the studies used vary considerably, e.g. concerning the availability of land, diminishing forest areas, and population growth. Analyses on biomass potential also show different results, depending on whether their focus is on what is socially and ecologically acceptable, or on what is technically feasible. Studies indicate that research mainly aimed at identifying biomass for bio-energy purposes tends to be more optimistic with regard to increasing yields and efficiency than research focussing on food security (IFEU 2014b). Ensuring food security should generally have priority over material utilisation and production of energy crops.

Achieving the Objectives of Decarbonisation Strategies in Aviation

For **Germany**, conservative estimates for the year 2025 show a biofuel potential of about 150 petajoule (PJ). Aireg places the prospective energy requirements of the aviation sector by 2025 at 425 PJ. A blend of 10%, as intended by aireg, would thus require 43 PJ of the domestic biofuel potential. Today's production of biofuels for road transport plus the 10% of aviation biofuels in 2025 roughly correspond to the amount of biofuels potentially available. However, this means that a large part of the bio-energy available would have to be used for aviation.

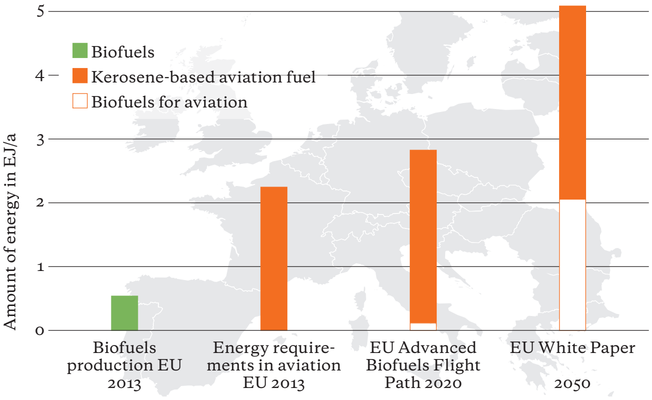
In the light of the growth forecasts in aviation, the sector's energy requirements will increase by

2 — The final energy consumption of the city of Cologne is about 75 PJ per year (20,700 GWh per year). The 10-percent target set by aireg (42.5 PJ) corresponds to about 60% of the annual final energy consumption of Cologne.

In order to meet the future demand for agrofuels, there is a need to increase the yields of energy plants. However, intensifying conventional agriculture will not be sufficient, and social and ecological factors are being neglected.

about 100 PJ, from about 330 PJ in 2012 to 425 PJ in 2025. Considering the domestic agrofuel potential of 43 PJ (10-percent target by aireg), this would still imply an additional demand for 57 PJ of fossil fuels. Against the backdrop of diminishing fossil resources, this won't lead to the desired outcome (DBFZ 2014).

European Energy Requirements in Aviation and Biofuels Production

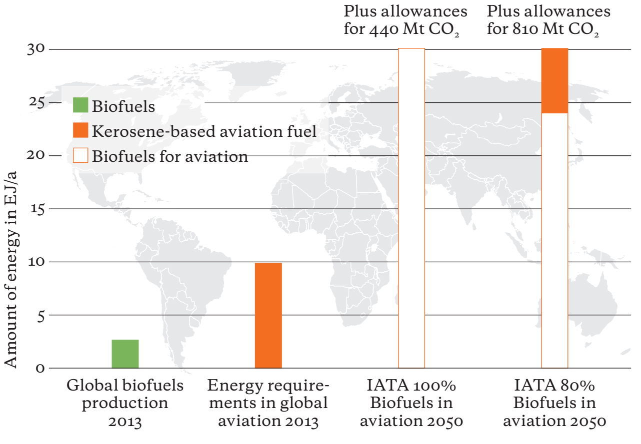


Adapted presentation, based on DG Ener et al. 2011; European Commission, 2011; F. O. Licht

Regarding **Europe's** agrofuel targets, figure 1 shows the use of biofuels in aviation in the years 2020 and 2050. The EU's Advanced Biofuels Flight Path target of two million tons of agrofuels in aviation by 2020 corresponds to about three percent of the energy requirements forecasted for the aviation sector. This is less than 20 percent of the amount of agrofuels currently produced in the EU. However, in this case, too, the base line is the general energy potential of all energy plants and it remains to be checked whether all of this energy may exclusively be used for aviation. The international production capacities are currently about 2.3 million tons (100 PJ) HVO as diesel substitute (Naumann et al. 2014). The 40% blend of agrofuels in aviation by 2050, as formulated in the EU's White Paper, however, is significantly more ambitious than the target set in the EU's Flight Path. The amount of energy needed would be four times the amount of alternative fuels currently produced.

In the light of the global reduction targets, there is an urgent need to reduce greenhouse gas emissions in aviation by half by 2050, as compared to 2005, as defined by the global umbrella association for airlines, IATA. Due to its rapid growth, the aviation sector erodes all CO_2 saving potential. The growth trends show that the current strategies and a focus on reducing CO_2 by using agrofuels are not sufficient. According to calculations by the German research centre on biomass DBFZ, IATA's target of a 50% reduction cannot be achieved with the technologies and agrofuel potentials foreseeable today, even in case of a complete substitution of aviation fuels (DBFZ 2014). Using CO_2 allowances (cf. figure) makes sense only if such allowances meet high quality standards and if the trade in emissions is supported by credible reduction targets and a clear limitation in the number of allowances.

Global Energy Requirements in Aviation and Biofuels Production



Adapted presentation, based on ICAO 2010

The forecast for the total energy requirement in aviation by 2050 is 30 exajoule (EJ). This is eleven times the amount of all alternative fuels produced worldwide in 2013, which were primarily used in road transport.

Looking at the feedstock used for agrofuels for aviation on the first successful test flights, we can see that the agrofuels used were mainly from energy plants grown in third countries, mainly newly industrialised and developing countries (DBFZ 2014). It can therefore be assumed that using only domestically produced agrofuels is highly unrealistic. The high costs of production are an aspect in disfavour of domestic crops and the consequences of a major expansion of the area under cultivation are yet to be discussed. It is thus to be expected that in the future the feedstock for aviation fuels will continue to be imported.

Increasing Yields – At What Price?

So far, first generation agrofuels are the main type relied on, but there are hopes for a new generation of alternative fuels (biomass from wood, waste, and algae) and a possible increase in efficiency in the use of fuels. The agrofuels which are currently available must be produced in a sustainable manner and without negative impacts on food security. This should be achieved by increasing yields and by using degraded or marginal land. However, there are already major conflicts over land as a valuable and scarce resource. Land is needed for the production of food and fodder, for grazing livestock, and for the cultivation of energy crops. In Africa, Asia, and Latin America we find examples of displacement, with the resulting unacceptable social and human rights impacts such as hunger and poverty.

According to estimates by the Food and Agriculture Organization of the United Nations (FAO), today's agricultural production must be doubled by 2050 in order to feed a growing world population that is going to be increasingly affluent (IFEU 2014b). This corresponds to a growth in production of 2.4 percent per hectare and year. Against this backdrop, it must be examined very carefully whether increasing yields of agrofuels for aviation is possible at all without competing with the food industry for land.

Intensifying Production

Studies show that there is indeed a high potential of increasing yields of food and energy crops worldwide. The factors that influence yields include nutrients, water scarcity, or the use of poor quality seeds. The ensuing yield gaps can be closed by a targeted intensification of agriculture. This would allow for a 45 to 70% increase in the production of most crops – which would contribute significantly to increasing the quantities produced, but would not be sufficient. At the moment, the current growth rates of the four most important crop yields (corn, wheat, soya, and rice) would not even be sufficient to produce the quantities needed to provide food security by 2050 (Mueller et al 2012).

Measures to Increase Yields

Today, increasing yields means above all a technical intensification of agricultural production by using more mineral fertilizer, pesticides, and irrigation. Most of the intensification measures of the past have led to degraded soils, pollution of water bodies, and regional water scarcity.

For example, due to wrong irrigation ten to 20% of all irrigated areas worldwide already suffer from salination, to an extent that yields have been decreasing (IFEU 2014b). Knowledge of the various dangers and possible conflicts brought about by such intensification measures, as well as alternatives to avoid them, must therefore be taken into account. Increasing yields involves the great challenge of making use of additional potentials without causing damage to the ecosystems. Local solutions and decentralised approaches to improve the availability of water and integrated management systems in agriculture, forestry and animal husbandry are to be promoted. Such measures also significantly improve the ecological footprint of agrofuels. Furthermore, knowledge from organic agriculture must find entrance into reforms of conventional agriculture.

Degraded Soil – An Option?

Apart from the intensification of agriculture, the utilisation of degraded land is also discussed as a possibility to increase yields. It is an attempt to avoid controversial indirect land use change (ILUC), by converting supposedly old, abandoned soil instead of primeval forests and valuable ecosystems into agricultural areas. According to Bai, as much as 18% of agricultural land is already considered degraded. That means, in line with the definition by the International Soil Reference and Information Centre (ISRIC), this land's ecosystem functions are lost for a long time (Bai 2009). However, the available data involve uncertainties. On the one hand, the definition of degraded land is incomplete. It does not explicitly distinguish between degraded, unused, and abandoned (agricultural) land. On the other hand, it is often difficult to identify the owners of degraded land, to find out how it is being used and who is using it. Most of the data are estimates and are based on the evaluation of satellite images, however, without detailed on-site assessments (IFEU 2014b). In many cases, people who have been using the land are being displaced. Their legitimate, often undocumented land use rights are not respected. According to studies, using land for the cultivation of energy crops is the main reason for land grabbing (Brot für die Welt 2013).

There is no problem with a long term rehabilitation and renaturation of soil that is really degraded and eroded. However, it can be assumed that the aviation sector will not adopt this complex and costly strategy.

The Low Indirect Impact Biofuels (LIIB) method is currently the only attempt to find a practical approach to identify unused areas for the production of energy plants. The LIIB method is still being tested in a pilot phase. Reliable results are not available yet. The Roundtable for Sustainable Biofuels is the only certification system for agrofuels that has included this approach in its existing certification structure.

Conclusion

Growth rates in aviation must decline. This may lead to less competition for agricultural products. According to Bread for the World, there is a danger that agrofuels for aviation – the big hope – may not be feasible. At the moment, the agrofuels available as an alternative that may serve to reduce emissions are mainly from oil-rich energy plants. It is therefore essential to produce them in a sustainable manner, i.e. without negative environmental and social impacts. Sophisticated certification systems like the International Sustainabiliy & Carbon Certification (ISCC) or the Roundtable on Sustainable Biomaterials (RSB) can be helpful in this regard. Approaches to intensify agriculture will be gaining importance, and so will methods to identify unused and degraded land in a reliable manner. The challenge lies in making use of additional yield potential without endangering the productivity of natural ecosystems and without further increasing the land use pressure on existing agricultural land which is already high. Increasing yields must not happen at the cost of food security and a growing world population. The aviation sector does not have priority in using the land. Furthermore, it is essential to encourage social processes to bring about change with regard to established consumption and mobility patterns.

Demands Addressed to Policy Makers and the Aviation Sector

1. Facilitate an institutional exchange between policy makers, the aviation sector, and environment and development organisations to ensure success and transparency in the implementation of climate-related measures to achieve targets in aviation.

2. Cut-back the growth dynamics and reduce energy requirements in aviation by factoring in external environmental costs through the polluter pays principle applied to emissions that contribute to climate change, and to air and noise pollution.

3. Promote a sensible transport mix that takes the ecological impacts of different modes of transport into account and contributes to changes in mobility behaviour.

4. Adapt production targets and quantities for agrofuels under particular consideration of increases in agricultural yields as well as ecological, social, and human rights criteria.

5. Produce agrofuels only in line with high standard sustainability certification such as ISCC or RSB, which take land use rights into account and try to prevent land grabbing.

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