January 2011
ISSN 1863-2017

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

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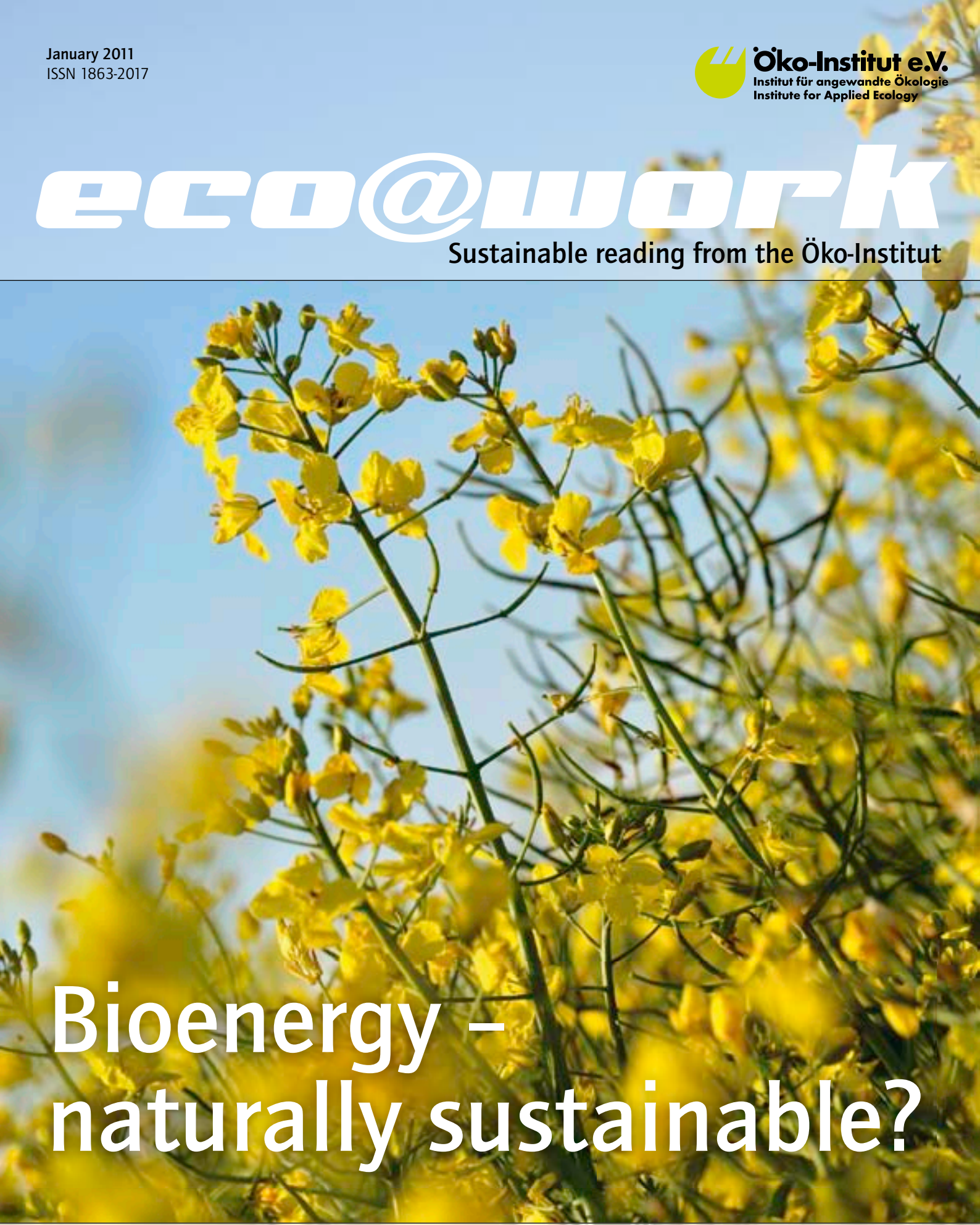
Sustainable reading from the Öko-Institut



Bioenergy – naturally sustainable?

We interview the President of the Federal Environment Agency Jochen Flasbarth on bioenergy strategies

Celebrating and continuing the research!

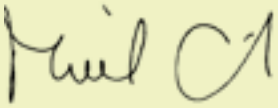
30 years old and still going strong. That was how the Darmstadt staff of the Öko-Institut felt last autumn at the celebrations to mark the 30th anniversary of their branch. The Darmstadt branch was founded in 1980, three years after the launch of the Öko-Institut in Freiburg. In the 1980s it entered vigorously into public debate on nuclear energy, power plant construction and waste management.

Nowadays our scientists – in Darmstadt and at all the Öko-Institut's locations – advise government departments, businesses and other civil society groups in Germany, the EU and beyond on sustainable lifestyles and sustainable ways of providing goods and services. This is what we celebrated last September during our annual conference, which addressed the subject of nanotechnology. And we shall be celebrating again at the forthcoming 20th anniversary of our Berlin office. It will be 20 years ago this month that our researchers in the newly reunified capital initiated the first studies in the cause of ecology and alternative energy research.

But the festivities at the Öko-Institut don't keep us from our work. On the contrary: we are actively conducting research in numerous scientific fields. This issue focuses on the subject of bioenergy and the use of crops to generate energy. Our scientists look at controversial topics such as the „food or fuel" debate and describe new, sustainable ways of using bioenergy.

An important component of a sustainable biomass strategy is a comprehensive certification system for biomass production and trade – including international trade. Our work also focuses on land-use change and the associated impacts on the climate balance of bioenergy. There are various questions for us to address in this context. For example, what steps can be taken to prevent rape, maize and other crops for biofuel production being grown on land that is needed for food production? What high-yield crops – such as fast-growing shrubs or energy grasses that in addition require little chemical inputs – are to be preferred for biomass production? How can we encourage cultivated biomass to be used for energy generation only at the end of a cascade of uses – for example, by using as energy feedstock the timber wastes that were previously unrecovered? The answers to these and other questions help sustainability standards for biomass to be developed in the EU and at global level.

I hope you enjoy reading the current issue of eco@work.



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Imprint

eco@work – January 2011, Published by: Öko-Institut e.V.

Edited by: Mandy Schossig (mas), Katja Kukatz (kk), David Siebert (ds)

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Design/Layout: Tobias Binnig, www.gestalter.de
Technical implementation: Markus Werz
Printed on100 percent recycled paper

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Account Details for Donations: Sparkasse Freiburg – Nördlicher Breisgau,
Bank Code No.: 680 501 01, Account No.: 2 063 447
IBAN: DE 96 6805 0101 0002 0634 47, BIC: FRSPDE66
Donations are tax-deductible for German income tax purposes.

„Very few of today's biofuels meet the EU's greenhouse gas reduction standards"

How can a long-term strategy for the sustainable use of biomass be formulated? To explore this question, the German Federal Environment Agency (Umweltbundesamt - UBA) commissioned the Bio-global research project, in which the Öko-Institut played a leading part. We interview Jochen Flasbarth, President of the Federal Environment Agency.

Mr Flasbarth, from January 2011 German filling stations will be able to sell petrol containing up to ten percent bioethanol (E10). Until now only five percent has been allowed. Is this good news for climate protection?

In my view the greatest opportunities for reducing CO_2 in the transport sector involve transport demand reduction, a shift to more environmentally friendly means of transport and greater vehicle efficiency. Biofuels such as bioethanol can then help to protect the environment and the climate if they are sustainably produced. That is why in the EU manufacturers of biofuels and of electricity from liquid bioenergy sources must show that they comply with sustainability standards and produce a certificate to prove it. Before we can judge whether E10 is good news, we must await the outcomes of biofuel certification.

What standards does biofuel certification set?

In Germany this is regulated by the Biofuels Sustainability Ordinance, which stipulates that the greenhouse gas balance of these biofuels must be at least 35 percent better than that of fossil fuels. In addition, the biomass used must not come from land with high carbon stocks or high nature conservation value, such as natural forests or peatlands.

Do all biofuels meet these criteria?

No. Our Bio-global research project shows that the greenhouse gas balance of biofuels varies widely depending on the raw material used, its origin and the way in which it is processed. Only a few of the biofuels on the market achieve the minimum reduction of 35 percent. Biofuels produced from wastes and residues do somewhat better. Biodiesel from palm oil and bioethanol from sugar cane only achieve this reduction if their production involves neither direct nor indirect conversion of carbon-rich land.

Are the biomass sustainability standards adequate?

In the past neither the Biofuels Sustainability Ordinance nor the EU directive on renewable energy has taken account of the greenhouse gas effects associated with indirect land-use change. In our view it is important to include these in greenhouse gas calculations. By the end of 2010 the EU Commission will submit a report on whether this can be done and if so, how.

When we will have sustainability standards for solid and gaseous bioenergy carriers?

Germany supports a European system of regulation; the EU Commission will report on this again at the end of 2011.

What is the position of the UBA in the „Food or Fuel" debate?

According to the Food and Agriculture Organization of the United Nations, the FAO, biomass for biofuels is being grown on about two percent of agricultural land worldwide. The sharp price rises that have affected certain foods in recent years are attributable to a variety of factors – biofuel production was only one of many. The causes of the food crisis included speculation on the commodity market, failed harvests – sometimes as a result of climate-induced weather changes – and dwindling food reserves.

How can competition between food and fuel be avoided?

We must use land as efficiently as we can. An important concept is cascade use: biomass should first be used for products – for example, wood should be used for furniture or as construction timber – and only after it has been used a number of times should it be used in the form of waste or residual material for energy. In addition, energy crops should only be grown on land that is not needed by the food and feed sector – perhaps on unused agricultural land or degraded land. The emphasis should be on systems of cultivation and land use that combine high yields with low inputs of agrochemicals and that have high genetic diversity. These criteria are particularly important for perennial species such as short-rotation tree plantations, and are also essential for energy grasses and integrated cultivation systems such as agroforestry or multi-crop systems.

What is being done at international level to ensure that cultivation of energy crops does not put biological diversity at risk?

Consider, for example, the 10th conference of the UN Convention on Biological Diversity (CBD) in Nagoya. There the parties were invited to develop national inventories of areas of high biodiversity and critical ecosystems that should not be used for the production of biofuels. They were also urged to identify areas particularly suitable for biofuel production. This was a first step in the right direction. But there are many other areas that deserve similar protected status – including land that is already being used.

Thank you for taking the time to speak to us.
Interviewer: David Siebert

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Jochen Flasbarth, 48, studied economics and has been president of the Federal Environment Agency since 2009. From 1992 to 2003 he was full-time president of Germany's Nature and Biodiversity Conservation Union (NABU).

Food AND fuel

Bioenergy is booming – but is it really sustainable? That depends on how it is produced and used. Sustainability certificates, cultivation of unused land and the use of biogenic wastes and residues can significantly reduce the adverse consequences of biomass cultivation for people and the environment and can mitigate climate change. These are the key findings of the „Bio-global" study conducted by the Öko-Institut and the Institute for Energy and Environmental Research (IFEU) on behalf of the Federal Environment Agency.

Biofuel from palm oil, wood pellets for heating boilers, biogas from food waste or coconut shells – bioenergy comes in many shapes and sizes. It is also seen as a sustainable and climate-friendly alternative to increasingly scarce fossil fuels: the amount of CO_2 released when the biomass is combusted is that which was previously bound during plant growth. This is why many countries are planning to expand production of cultivated biomass, and why at its international conference „World Biofuels 2010" the biofuel industry announced that by 2045 it wants 480 million hectares of land to be used to grow energy crops. That's an area 50 million hectares larger than the EU.

But scepticism is also growing. When there are more than a billion hungry people in the world, can we afford to use agricultural commodities for fuel rather than food? Won't increased cultivation of energy crops stifle food production, causing food prices to rise and exacerbating the world hunger crisis? Doesn't the conversion of forests, mires and savannahs into farmland cause biological diversity to be irreversibly lost and also release large quantities of greenhouse gases?

„The ever-increasing use of biofuels – for example blended with petrol or in electricity production – is the result of policy requirements. The EU directive on the expansion of renewable energy stipulates that by 2020 twenty percent of the EU's total energy need must be met by solar power, hydropower, wind power, geothermal energy and biomass. The directive also requires all EU member states to meet ten percent of their need for road fuels from renewable energy – especially biofuel – by 2020", says Uwe Fritsche, scientist and bioenergy expert at the Öko-Institut. „If policy-makers are laying down such requirements, they must also accept responsibility for the consequences".

The EU has responded to critical questions raised by the media and the European Parliament. The EU directive now includes binding sustainability requirements for biofuels: biofuels and liquid biomass fuels produced in the EU or imported from third countries must have certification to show that they do not originate (or that they originate in compliance with very stringent standards) from areas important for biodiversity, such as primary forests or nature conservation areas, or areas important for carbon storage, such as wetlands and peatlands. It must also be demonstrated that these biofuels deliver greenhouse gas savings of at least 35 percent (60 percent from 2018) compared with fossil fuels.

Blind spots in sustainability standards

„„The development of a certification system for biomass is a step in the right direction", says Fritsche, „but there are still gaps in the EU sustainability standards for biomass." Criticism is also expressed by environmental organisations such as the European Environmental Bureau (EEB) and the Worldwide Fund for Nature (WWF): they point out that where energy crops are grown outside the EU, adverse impacts on air, water and soil need only be reported, not prevented. Doubt is also cast on the credibility and transparency of agreements with producer regions and on the efficiency of local monitoring systems.

In the light of these concerns, the Federal Environment Agency commissioned the Öko-Institut and the Institute for Energy and Environmental Research (IFEU) to undertake the „Bio-global" project, which looks at the standards that the international biomass trade must meet if bioenergy production is to be certain of being sustainable. „Because of world trade rules, social issues cannot be included in mandatory biomass certification", quotes Fritsche, project manager of the study, as an example. „We have therefore drawn up proposals for

social standards that would guarantee that human rights and labour rights are observed; on energy crop plantations in developing and newly industrialising countries these rights are often breached."

Of all-round relevance: land-use changes

An important issue in the Bio-global study is that of land-use changes triggered by biomass production and the consequences for climate, biodiversity, water quality and water resources as well as for land-use rights and the living conditions of the rural population. In particular the study points out that the EU directive does not at present consider the greenhouse gas effects of indirect land-use changes. „Direct land-use changes occur when energy crop cultivation destroys ecologically valuable or carbon-rich land", explains Fritsche. „But indirect land-use changes may have equally severe consequences. When existing crops such as rape, wheat or maize are used for biofuel production, the demand for the food and fodder that they represented remains unchanged", he says. „Production for the world market then shifts to other

land." These displacement effects, which may take place across regional or national borders, often give rise to significant CO_2 emissions which are indirectly caused by biomass cultivation and should be attributed to it.

Model calculations in the Bio-global study show that in the case of biofuels from rape, wheat and maize the greenhouse gas effects from indirect land-use changes are very high. If they are included in the climate balance, these biofuels do not meet the EU's 35-percent greenhouse gas reduction target. From a climate perspective, therefore, it is questionable whether their production can be justified. The situation is different for biofuels from palm oil, sugar cane and second-generation (BtL) biofuels from energy grasses or short-rotation plantations of quick-growing trees or shrubs: there biofuels meet the EU requirements even if greenhouse gas emissions from indirect land-use changes are taken into account, provided that cultivation of the biomass does not involve clearing savannahs or forests.

Opportunities and limits of sustainable biomass

But what form might sustainable development pathways for biomass production take in future? „A much-discussed proposal is to avoid adverse impacts on food security and the environment by drawing on previously unused land", explains Dr Klaus Hennenberg, scientist at the Öko-Institut and co-author of „Bio-global". According to scientific studies, more than ten percent of land worldwide is abandoned and slightly degraded farmland. Biomass grown on this land could in theory yield around 75 exajoules of energy annually – enough to meet around 15 percent of the global energy need. To explore how this land could be identified and made usable, the Öko-Institut has developed a system in which available geographic data is supplemented by remotely sensed data, sometimes obtained by satellite. „We have successfully tested this system in country studies conducted jointly with local partners in Brazil, China and South Africa", reports Dr Hennenberg. „However, it was found that the amount of potentially usable land is being significantly overestimated." Nevertheless, the country studies demonstrate that suitable land exists – even if there is less of it than originally anticipated. Appropriately managed cultivation of biomass on this land could bring ecological and socio-economic benefits, especially if regionally adapted mixtures of energy, food and feed crops are grown.

A further way of preventing future bioenergy use from causing environmental damage or conflicts between „food and fuel" put forward by the Bio-global study is the concept of „cascade use" of biomass. „Cultivated biomass is a scarce resource; in should in future be used primarily for food and in products such as building materials and furniture. Energy production should in future involve mainly wastes and residual matter", is how Fritsche describes the strategy for sustainable biomass use. „Straw, timber waste, liquid manure or food waste are ideal energy carriers for the future, because they arise anyway in agriculture and in the food and timber industries. They give rise to virtually no additional risks to land, water, biodiversity or the climate. In addition there is no competition with food production for their use." The German Advisory Council on Global Change (WBGU) puts the global sustainably usable potential of biogenic wastes and residues at about 80 exajoules per year, about half of which could be economically worthwhile to exploit. „However, development of the technologies involved and of the logistics for utilising waste and residual biomass needs to be better promoted", emphasises Fritsche.

„Overall we estimate that the global bioenergy potential that can be made available by growing sustainable energy crops and utilising wastes and residues is equivalent to between ten and 15 percent of the world energy need", is how Fritsche sums up the situation. „This means that sustainable bioenergy is a cornerstone of the reconfiguration of energy systems." The Öko-Institut is continuing to research this issue. On behalf of the Federal Environment Ministry (BMU) it is assessing the sustainable potential of surplus straw in Germany for energy purposes. A study for the Federal Environment Agency (UBA) aims to clarify how biomass in Germany can be sustainably used for products. The question of which mechanisms for financing bioenergy projects in developing countries can be used to ensure sustainability is being pursued in a study for the Global Environment Facility (GEF).

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Bioenergy in Germany

Energy from cultivated biomass currently provides 3.9 percent of the electricity used in Germany, 6.1 percent of the country's heat and 7.3 percent of its road fuel. The Federal Environment Ministry estimates that by 2020 bioenergy could meet 11 to 15 percent of the primary energy requirement.

Algae – another option?

Can the plant-like organisms provide a source of sustainable energy for the future? This question was discussed at an international expert workshop that formed part of the Öko-Institut's Bio-global research project. The outcome: sustainable bioenergy from algae lies very much in the future. It will be at least ten to 20 years before aquatic biomass can make a significant contribution to bioenergy production – if it happens at all.

Scope for growing energy crops is limited by the amount of land available. In addition, there may be adverse impacts on biodiversity and the climate as a result of land-use changes, and competition with food production may also occur. Scientists and industrialists are therefore searching hard for alternative sources of biomass. Algae are one possible candidate. This is why the American oil giant ExxonMobil has recently launched a 600-million-dollar research project aimed at developing a biofuel from algae. Media and PR reports are already depicting optimistic scenarios. Will aeroplanes soon be powered by algae biofuel? Or will we shortly be seeing bioreactors that use algae on a large scale to produce biogas or fuel for hydrogen cars?

In its bioenergy research project Bio-global the Öko-Institut has also considered whether algae could provide a sustainable source of energy. As part of its research, the institute – with the Institute for Energy and Environmental Research (IFEU) – organised an international workshop which served as a dialogue forum for scientists and businesspeople from all over the world. The reports that were presented ranged from the research findings of European, American and Asian institutes to descriptions of practical projects involving, for example, the cultivation of micro-algae for biofuels in Brazil and the production of bioethanol from red algae in Korea. „Sustainable bioenergy from algae is still very much in the future" is how Dr Klaus Hennenberg, bioenergy expert at the Öko-Institut, sums up the results of the algae workshop.

In theory there are advantages to producing bioenergy from algae. Most algae live in water and many species are salt-tolerant. Breeding them therefore entails no use of land or scarce freshwater resources. They could be cultivated in the sea or in special facilities on land not suited to other uses. Their cultivation would thus not compete directly with food production. Moreover, there are algae species that thrive very well in polluted water, since they can use nutrients – such as fertiliser – in waste water for their growth. Algae therefore function as organic filter systems and can be used to purify water. In addition, algae have higher energy efficiency and faster growth rates than many land plants.

High expectations – unrealistic in practice

In principle, bioenergy can be produced from both macro-algae and micro-algae. In particular, micro-algae produced in photoreactors in land-based systems – currently used mainly for medical and cosmetic products – could in future account for a growing share of bioenergy provision. „This assertion is often justified by pointing out that these microscopically small unicellular or multi-cellular organisms achieve area yields that are up to ten times higher than those of land plants", explains Dr Hennenberg. „In the scientific literature it is stated that for the same energy yield algae biofuels need less than three percent of the land required for maize or sugar cane." However, the Öko-Institut scientist regards this claim as exaggerated: „Statements about such high area yields are often based on extrapolation from laboratory results that cannot realistically be put into practice." The use of land and water resources for land-based cultivation of micro-algae could, moreover, pose risks to the environment if production does not meet sustainability criteria.

Macro-algae are at present cultivated almost exclusively in the sea or harvested from natural stocks. In their case, too, high expectations need to be revised. It is true that the highest biomass yields are obtained from these algae in tropical, coastal waters; their cultivation could therefore represent an opportunity for developing countries. And a study of the Food and Agriculture Organization of the United Nations (FAO) estimates the biomass potential of micro-algae in climatically suited coastal zones at up to 7,400 million tonnes of biomass per year – equivalent to three percent of global energy demand. „But whether these high estimates of macro-algae production potential could actually be exploited is extremely doubtful, for environmental as well as technical and economic reasons", stresses Hennenberg. Scientists at the algae workshop pointed out that these very coastal zones are already subject to severe pressure of use and significant environmental stress. Moreover, coastal waters often contain ecosystems with high biodiversity that should be protected and in which algae cultivation should not take place.

The workshop also highlighted the fact that environmental concerns are not the only obstacle to the use of bioenergy from algae: economic parameters and the insufficiently advanced state of technology pose further problems. „The production of micro- or macro-algae as a raw material for bioenergy is at present uneconomic, because of low fossil energy prices", reports Dr Hennenberg. „However, using residues from existing algae production for conversion to energy it can be worthwhile even now. Algae breeding could also help to reduce nitrogen and phosphate pollution from the increasingly important aquacultures for fish, thereby producing biogas as a by-product – that would be comparatively low-cost and sustainable." In addition it became clear that technical problems with cultivation and extraction of the biomass present difficulties. „Given the current state of technology and energy costs", says Dr Hennenberg, „it is likely to be at least ten to 20 years before aquatic biomass can make a significant contribution to energy generation." The algae workshop highlighted the need for further research. There are still important questions to be answered, for example regarding the damage that macro-algae might do to natural ecosystems or the energy and greenhouse gas balance and water consumption of micro-algae. Until the answers are known, the sustainability of algae biomass cannot be regarded as proven.

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