

> Biotechnological energy conversion in Germany

Current Status, Background and Future Prospects

acatech POSITION PAPER – SUMMARY AND RECOMMENDATIONS



Germany has committed to pulling out of nuclear power completely by 2022 and switching to renewable energy for a proportion of its energy supply. Alongside solar and wind power, biomass energy will play a key role in this changeover, since more than two thirds of all renewable energy currently being supplied comes from biomass, which is the main energy carrier for renewable heating and fuel. Biotechnological energy conversion is a process that enables biomass to be converted into storable energy.

What is biotechnological energy conversion?

As with all bioenergy solutions, biotechnological energy conversion generates electricity, heat and fuel from renewable raw materials rather than non-renewable fossil fuels. Biotechnological energy conversion harnesses enzymes, cells or entire organisms to convert the biomass into material energy carriers such as methane (biogas) or ethanol. Compared to the chemical processes that are currently being deployed to produce biodiesel from vegetable oil, for example, biotechnological conversion uses less energy and can be more easily implemented at a local level. Furthermore, a wide variety of source materials may be used. Biogas is generated by fermenting slurry, cattle dung and plant biomass (at this point in time predominantly maize). The biogas is then converted into electricity and heat in combined heat and power (CHP) stations. Biogas can also be used to provide heating or fuel for motor vehicles. Bioethanol is produced by fermenting plants containing sugar and starch. There are currently a number of pilot or demonstration projects for biotechnological processes geared towards lignocellulose conversion. Bioethanol can be used as fuel for the internal combustion engine. One example that recently hit the headlines is E10 ethanol fuel containing 10 percent ethanol. When German petrol stations started selling this product, there was a heated debate about how safe it is to use and how sustainable it really is.

Biomass energy should be used where it constitutes the best alternative, i. e. as a storable energy carrier for fuels.

Renewable biomass energy can help address the energy supply challenges that we are currently facing. It can help combat climate change by lowering greenhouse gas emissions, reduce our dependence for energy on non-renewable fossil fuels and contribute to an environmentally and socially sustainable economy. Wind and solar power provide effective alternatives to fossil fuels and nuclear power for generating electricity and are capable of producing more energy per square metre than biomass. Where biomass comes into its own is as a means of producing energy carriers such as biogas, bioethanol and other easily storable and transportable products. Biomass is thus particularly suited to use as a fuel source.

Biotechnologically produced fuels may defuse the "fuel vs. food" debate.

It is important that second-generation biotechnological processes should be employed to produce biofuels. These use waste materials from agriculture and forestry as well as sewage and waste gas. Currently, it is mostly oils, starch and sugar that are being used for conversion into storable bioenergy carriers, since converting them is relatively straightforward from a chemical and biotechnological point of view. The problem is that these substances' primary use is as foods. Rapid population growth has been accompanied by growing demand for food and animal feed, leading to increased competition for the limited arable land available between energy-rich biomass and food crops. In order to resolve this conflict, we must seek to employ raw and waste materials that are unsuitable for consumption as food in the production of bioethanol and biogas fuels. This will allow the limited arable land available to continue to be devoted to food production.

By reducing competition for arable land, it will also be possible to decouple food and bioenergy crop prices, since increased bioenergy crop cultivation has been identified as one of the causes of the recent hike in market prices for food.

Furthermore, using waste materials is more environmentally friendly than biomass crops, since it does not generate the extra greenhouse gas emissions that result from the use of fertilisers. Biotechnological processes also allow waste materials to be converted into energy locally, facilitating a decentralised approach that cuts transport requirements.

Biotechnological energy conversion has commercial potential. Government and industry will need to create favourable conditions to enable it to achieve commercial success.

Biotechnological energy conversion enables combined production of energy and higher-valence chemicals. Furthermore, the fermentation residue can be recycled as agricultural fertiliser and may also be used to make compost. Consequently, continued development of this process will open up significant value creation opportunities for German businesses. Germany also has the chance to position itself internationally as an exporter of equipment for biotechnological processes and energy carriers. The current size of the global ethanol market is 100 billion litres, however it is forecast that over the next three years second-generation ethanol will only account for a few percent of total production. Biotechnologically produced fuels and the associated technologies have huge potential. However, the first places where second-generation biofuel processes will become established will be in those parts of the US and those European and newly-industrialised countries where pilot plants are

already up and running. While Germany is a world leader in biotechnological energy conversion research, it is other countries that are increasingly marketing the new second-generation products. Germany cannot afford to get left behind its international competitors if it wishes to maximise the value creation opportunities.

Processes for deriving material energy carriers from raw material waste have not yet become established commercially. They require more complex technology compared to the relatively simple processes for converting oil or sugar. The International Energy Agency (IEA) expects that production costs for conventional ethanol will remain lower than for ethanol made from lignocellulose waste – such as straw, bagasse and other crop residues – until at least 2050. It is also expected to take some time before lignocellulose ethanol can compete with fossil fuels. Despite the fact that the conversion of raw materials not used for food production into storable energy carriers is both technically feasible and will become commercially viable in the long term, the more complex process currently required to do so represents a major obstacle to market acceptance. Furthermore, even if it were to prove possible to market it successfully, biotechnological energy conversion from raw material waste faces another serious challenge: it is already becoming apparent that there will not be enough biomass to generate the liquid and gaseous energy carriers needed to meet the EU's bioenergy targets for the fuel sector if biomass burning continues to increase at its current rate. If biomass burning is to be scaled back in favour of biotechnological fuel generation, it will be necessary to engage in a dialogue with the public, since despite widespread support for renewable energy, society can be rather wary about biotechnology.

SUMMARY OF RECOMMENDATIONS

1. Promotion of research and development

acatech recommends that second-generation biotechnological energy conversion should be further developed into a commercially viable process.

If it is to be marketed successfully, the support promised by the German government's 6th Energy Research Programme for large-scale demonstration projects will be of central importance. Funding should continue to be provided for the development of processes geared towards exploiting waste materials.

2. Biomass utilisation strategy

acatech recommends political intervention to manage the way that raw materials are deployed across different market segments, and in particular an end to the promotion of biomass burning.

Targeted promotion of biofuel technologies that do not compete with food crops should help make these technologies more commercially viable. Biofuels will require a stable, long-term legal framework similar to that provided for renewable electricity by the German Renewable Energy Act. The incentives for increased biomass burning should be removed.

3. International cooperation

acatech recommends closer international cooperation with biomass-rich countries with regard to process development. Working with these countries will be key to ensuring commercial success.

Germany's strength in the field of process engineering can be used to optimise the process in the mutual interests of both parties.

4. Education and training

acatech recommends that an interdisciplinary approach to research "from genes to fuel" should be integrated in a targeted manner into the education and training of scientists and engineers.

Analysis of the potential repercussions of technologies and associated safety issues should form an integral part of both education and training and individual research projects.

5. Communication

acatech recommends that public communication activities should make it clear that a biobased, sustainable economy cannot be achieved without engineering and new technologies.

It is important that information campaigns on biotechnological energy conversion should inform the public about the pros and cons of both fossil-based and biomass-based energy generation.

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