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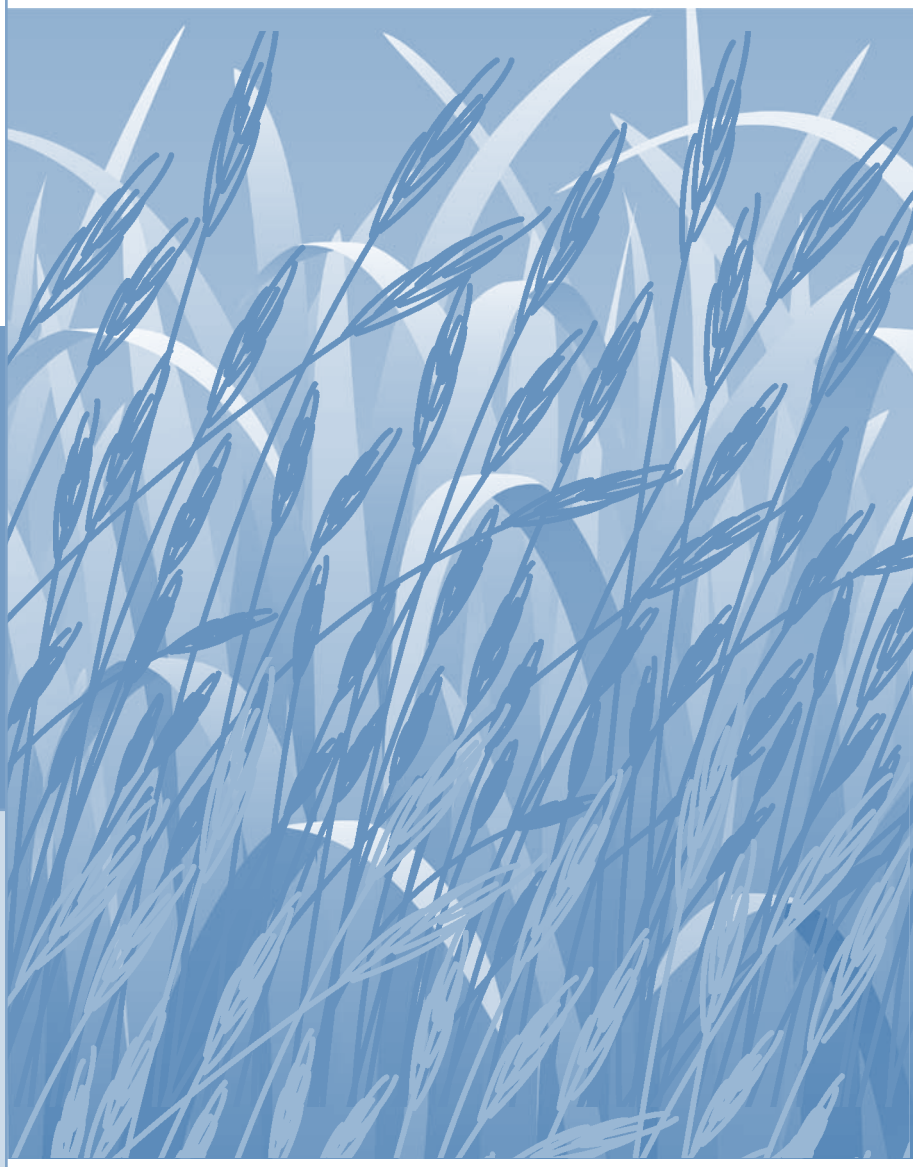

Biomass as a Resource for the Chemical Industry

Key findings of an IFEU study
and conclusions of the VCI

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BACKGROUND

Massive increases in the prices of fossil fuels and above all for oil and gas together with the climate debate have strengthened public interest in the use of regenerative carbon carriers – also known as renewable resources or renewables. For decades, the industrial use of renewable resources has been largely confined to their use as materials in the chemical and wood/materials industry. The use of bio-based resources for energy generation and as fuels is now experiencing a dramatic boom, primarily as a result of State funding.

What has become a worldwide boom in the use of biomass for industrial purposes outside the food sector has very quickly revealed biomass's limitations. The rise in the price of renewable resources themselves and particularly of foods and even shortages in certain sectors have illustrated that renewables are not inexhaustible.

The chemical industry is a major purchaser of renewable resources. From the outset, it has been investigating the scope for the use of renewables in chemical production. As a result of energy generation and the production of fuels combined with expanding demand for food from a growing world population, there is increasing competition for renewable resources. The VCI has therefore commissioned a study on this issue from the IFEU – Institut für Energie- und Umweltforschung Heidelberg GmbH (Institute for Energy and Environmental Research).

ABOUT THE STUDY

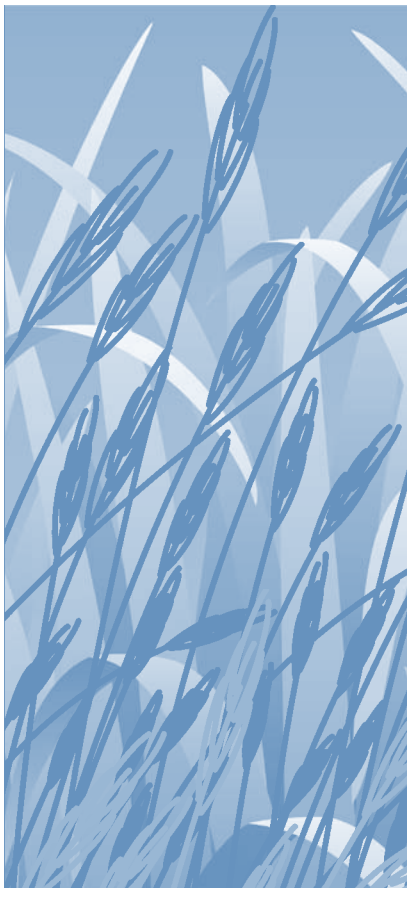
The study analyzes the background and addresses four central questions:

1. What realistic quantities of biomass are available for technical applications at all if maintaining a reliable supply of food to a growing world population is taken into consideration? Is it possible, as repeatedly claimed and expected by politicians, to completely substitute today's fossil fuels with renewables?

2. What effect does the use of renewable resources in the chemical industry have on the solution of the much-debated climate protection problems and the problem of the finitude of fossil resources? Can mineral oil products and natural gas be replaced by renewable resources on a significant scale and will greenhouse gas emissions thus be reduced to an appreciable degree?

3. Is there a Royal Road for the use of renewable raw materials? Should the finite quantities of biomass mainly be used for energy generation; or for supplying the transport sector with biogenic fuels; or is its use as a material in the chemical industry the most efficient use?

4. Which strategies for biomass use are advisable in the chemical industry in terms of fossil resource conservation, reduction of greenhouse gases, biomass availability and cost?



KEY FINDINGS OF THE IFEU STUDY WITH THE VCI'S CONCLUSIONS

1. The chemical industry of necessity requires carbon-containing resources for the production of organic chemicals. At present, these are mainly of fossil origin, such as mineral oils and their downstream products, natural gas and coal, but also include over 10 per cent renewable raw materials of animal and plant origin. Various biomass resources are available as regenerative carbon-containing raw materials. Although carbon-based resources are mainly used today for energy generation and as fuels, other regenerative alternatives are also basically available as an alternative to biomass, e.g. solar, hydro- and wind power.

2. Biomass is already being used in a wide variety of areas today – as food/feed, for the generation of electricity and heat, for fuels, as a material and resource in the industrial sector and particularly in the wood, paper and chemical industry. There is basic competition among these uses. This is also associated with competition for land under cultivation. The cultivation of additional biomass, for example, competes with the preservation of existing ecosystems (e.g. tropical rainforests), as well as with other sustainability goals such as nature conservation (e.g. the extension of habitat networks and the preservation of biodiversity) and the expansion of organic farming. If, for instance, the already agreed sustainability goals were consistently realized in Germany and, at the same time, agricultural self-sufficiency were held at the present level, there would be no more land available for the cultivation of renewables. In view of the already evident competition for biomass and land, it is essential to develop the most efficient uses.

3. The future possible uses of renewable resources will depend essentially on the quantity of biomass available. The estimation of potential biomass is associated with high uncertainty. The estimated ranges are therefore extremely broad. The availability of biomass for industrial applications is strongly affected by numerous factors: Demographic trends and the future eating habits of the growing population, progress in agriculture (better plants, higher output, better techniques for yield enhancement) as well as climate change and the availability of water.

1

VCI conclusion

The use of biomass, as the only carbon-containing regenerative resource in chemical production, should be encouraged in those areas where it makes sense and is sustainable.
At the same time, sufficient flexibility in the resource base should be maintained in order to safeguard production in the long term.

2

VCI conclusion

There is already considerable competition in the use of the land available on earth and among the possible uses of biomass itself. From these possible uses, society must in consensus select the most efficient ones from the economic, ecological and social points of view.

3

VCI conclusion

Owing to the huge uncertainty in estimates of long-term potential and hence of the actual availability of biomass, longer-term goals for biomass use in certain areas can only be set with great caution. Biomass cannot of course be put to multiple use. For this reason, the emphasis must be on:

- *the complete exploitation of the finite quantities of biomass by optimizing processing methods (e.g. practical implementation of bio-refinery strategies) and*
- *optimizing supplies of biomass (e.g. by broadening the use of plant biotechnology).*

4

VCI conclusion

The potential for expanding the use of biomass in the coming years is considerable but nevertheless limited.
As things look today, it will not be possible to satisfy primary energy requirements exclusively with biomass. Three avenues would appear to be necessary and sensible:

- *The drafting of an integrated strategy for the possible biomass uses that show the highest economic, ecological and social efficiency.*
- *The development of technologies for the exploitation of non-biogenic regenerative energy sources has to be accelerated.*
- *All technologies, and particularly the opportunities provided by plant biotechnology, must be developed and exploited in order to achieve the highest possible yields.*

5

VCI conclusion

Even in a "biomass-based economy", Germany and Europe will remain highly dependent on imports. This will have considerable consequences for the future biomass strategy in the EU and Germany. Above all, it is essential that the resources required by the chemical industry are supplied at competitive world market prices. If Germany and Europe do indeed wish to reduce their dependence on imports of energy resources, technologies for other, non-biogenic regenerative energy sources will have to be encouraged.

6

VCI conclusion

Provisional assessments of possible savings of fossil fuels and greenhouse gas emissions by using biomass in the chemical industry are promising. To obtain an overall picture, however, farther-reaching analyses – of cost-effectiveness, technical feasibility and other environmental effects – are urgently required.

4. On the basis of the energy content of the biomass available in the future, biomass will be able to contribute between 6 and 15 billion metric tons of crude oil equivalent (COE) in the year 2050. Estimates of global primary energy needs for 2050 vary greatly according to the scenario on which they are based. The International Energy Agency (IEA) has forecast demand of approximately 17.5 billion tons of COE for 2030. An extrapolation without incorporating any major advances in energy efficiency yields demand of around 20 billion tons of COE for 2050. This means that between 30 and, in the most favorable case, 75 per cent of primary energy requirements could be met by biomass in 2050. Initially, this applies solely to energy use. When used as fuel and in the chemical industry, it should be noted that, because of in some cases considerable conversion loss, the full theoretical energy content is not obtainable.

5. Future biomass potential is distributed very unevenly worldwide. The lion's share is to be found outside Europe. As things look today, the biomass available in Germany will only suffice to meet 10 to 17 per cent of primary energy needs in 2050. In Europe, a maximum of 10 to 16 per cent of the anticipated energy needs could be met. These estimates deflate the frequently cited argument that Germany's and Europe's dependence on imports of energy resources can be significantly reduced by making more intensive use of home-grown biomass.

6. For an initial provisional assessment of the use of biomass, the study has confined itself to the conservation of fossil fuels and the avoidance of greenhouse emissions. The cost-effectiveness of individual uses and the actual technical feasibility of the various avenues have been disregarded. These would have to be analyzed at the next stage. By using biomass in chemical production, considerable quantities of fossil fuels and greenhouse gases can be saved. The scope for savings is large in some areas and depends on the type of energy used in the production process, for example. If the energy requirements for the processes in which renewable resources are used are met by fossil fuels, the total savings are significantly lower than if the energy requirements are met by regenerative energy sources. We were unable to identify preferred technologies. Ultimately, it is the combination of the available biomass used, the conversion technology applied and envisaged target product that decide on the level of savings of energy and greenhouse gas emissions.

7. In a direct comparison of the chemical industry, transport and energy generation as potential uses, the direct combustion of dry biomass to generate energy shows the biggest potential savings. The processes for this already largely exist and are in practical use. Uses in the fuel sector or in the chemical industry with similarly high potential savings are still at the development stage.

8. The chemical industry sees two basic strategies for the future use of biomass:
   - The production of basic chemicals by completely degrading biomass into so-called C1 units by using the synthesis gas process. The specific potential savings are relatively low, but the total potential is considerable in view of the large quantities involved.
   - The production of in some cases more complex functional compounds by exploiting upstream natural synthesis processes. The specific potential savings are relatively large for the individual product lines, but the potential quantities are relatively small for the large number of individual compounds.

   The pursuit of these two avenues is still very limited at present. The production of basic chemicals using the syngas process is still far from cost-effective. The production of functional compounds well beyond the today's scale is still at an early stage of development and is not basically more sustainable than classical synthesis processes.

9. There are considerable technical, economic and logistical obstacles to the intensified use of renewable resources in the chemical industry:
   - Innovative biomass conversion methods and synthesis processes for chemical products are still at the development stage. Reliable forecasts from the idea through to the marketability of plant strategies and products are not possible at present.
   - There is considerable uncertainty about the expected product costs and hence about profitability and competitiveness. Biomass resources represent the biggest cost factor. How this cost item will develop is impossible to estimate. The cost of investment in innovative processes (e.g. bio-refineries) can only be estimated within broad limits.
   - There is still considerable need for research. Process optimization, improved efficiency and the development of new enzyme systems and new sustainable synthesis processes are necessary in order to achieve economic viability.

7

VCI conclusion

The direct use of biomass for energy generation shows the biggest potential savings and can be practically implemented today. The use of biomass as a material and more efficient fuel use, on the other hand, still need considerable development. The current concentration on energy use therefore makes sense for a transitional period. In the long term, however, the sustainable use of biomass as a material must play a larger part. For energy supplies, other regenerative energy sources that do not compete for agricultural land must be developed further, e.g. solar cells, solar collectors, geothermal energy, wind power and hydropower.

8

VCI conclusion

The use of biomass for the generation of substances in the chemical industry beyond the present scale calls for considerable research and development efforts.

9

VCI conclusion

In the light of the known considerable technical, economic and logistical obstacles to the intensified use of biomass/ renewables in the chemical industry, specific targets, administrative regulations and attempts to exercise influence with fiscal or economic tools will tend to be counterproductive. The one-sided State subsidies for energy and fuel use are already making the use of biomass as a material less competitive.

Politicians are in fact called upon to create a framework that will encourage the necessary research and development and eliminate the competitive disadvantages associated with the import of renewable resources.

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