What would it take to unlock the full potential of biofuels?

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Long-term, globally sustainable biomass

The key formula of a long-term strategy (2050 horizon) for sustainable biomass is that renewable resources are **primarily** used as **raw materials**, whereas waste and biomass residues – stemming increasingly from used products made from renewable raw materials - mainly serve as **energy sources** (i.e. for electricity, heat, and transport). This couples renewable raw material needs (which are growing when "greening" the economy) with renewable energy needs (which are growing when decarbonizing the global energy system), thus avoiding feedstock competition.

To decouple competition **for land**, renewable raw materials (biomass) must **primarily** be cultivated on **unused** or degraded land, or land with limited suitability for food and feed production, taking into account "no-go" areas to respect nature conservation and biological diversity needs. Preferred plants and cultivation methods are those requiring low input in agro-chemicals and water and have a broad genetic basis, e.g. perennial grasses, oil-bearing plants, and short-rotation coppices.

After the material use of biogenic raw materials, their subsequent **energy** use is a sensible option, i.e. for generating electricity and heat or as fuels. Here, not only biofuels derived from residues and wastes are important, but also - due to the increased electrification of vehicles – bioelectricity, so that the boundary between the sectors of bioenergy use gradually vanishes over time. When processing biogenic raw materials, integrated concepts such as biorefineries involving multiple product use may become significant as well.

Of key importance for this strategy is the modernization of waste management as the "back end" of material use, which has to provide adequate logistics for biogenic waste and residuals as a precondition of their subsequent energy use.

The logic of sustainable biomass, therefore, is to use the **structural value** of biomass (for food, fiber and other material uses) **first** and the heating value (energy content) of the material only after the structural value is "spent".

Thus, instead of the currently prevailing cultivation of biomass for direct conversion into bioenergy for power, heat and fuels, a **cascaded use** will be practiced in the future which will largely **disconnect** the production of food and feed from that of renewable resources both with respect to the plants and the land used.

Therefore, cultivating food and feed plants for energy or material use is but a **medium-term transitional strategy**.

The conversion of biogenic waste and residuals to so-called 2nd generation biofuels and to biomethane (from synthesis gas or biogas) will complement (co-)combustion in combined heat and power generation plants.

In addition, bioenergy **trade** will gain new opportunities because the quantity of biogenic residuals and the final use of the biogenic energy carriers obtained can also be disconnected **spatially** (e.g. through bioethanol and liquefied gas tank ships or supply to natural gas networks).

In the long term, sustainable bioenergy may contribute up to 25% to the global energy input because its area-specific energy yield remains substantially below that of solar systems, and because land needed for biogenic cultivation systems and the required material inputs (especially water) are limiting factors.

In addition to terrestrial biomass, **highly productive algae** may play a role as a raw material supplier and may be integrated in aquaculture systems where they utilize excess organic residuals and nitrogen.

With this strategy, the often-quoted “food versus fuel” problem would be diminished, and the positive social and economic development options arising from sustainable biomass especially for developing countries and emerging economies could become the focus of the discussion: Access to modern bioenergy, valorization of underused and restoration of degraded land can contribute to rural development and generate income which in turn allow reducing pressure on forests, wetlands, and other areas of high biodiversity.

Implementing sustainable biomass strategy

This strategy clarifies the long-term role of biomass as a significant **part** of sustainable energy **and** material resources. Thus, it can provide a reference for those having critical views on bioenergy (due to potential threats for environment and livelihoods) and for bioenergy promoters (interested in the market potential).

Key to implementing this strategy and to “unlock” the sustainable potential is to **harmonize and globalize**

- climate protection requirements, especially convention on methods to determine greenhouse gas emissions including those from land-use change, and respective reduction goals;
- land and landscape-related protection of biodiversity with respect to biomass cultivation;
- social safeguards for using degraded land, and for working conditions in the labor-intense biomass supply and conversion systems.

For this to become effective, it is necessary to amend the relevant global conventions by setting clear requirements for all parties involved and their verifiable implementation in order to ensure the effectiveness of all rules relating to sustainable biomaterial and bioenergy markets.

As regards the UN Framework Convention on Climate Change and the UN Convention on Biological Diversity as well as their protocols, this would mean that the potentially negative consequences of **indirect** land use changes on climate protection and biodiversity would be **generally avoided** if the application of CO_2 emission limits also included global land use changes and areas rich in biodiversity were globally protected.

With regard to the private sector which will have to invest in sustainable biomass supply, trade, and conversion, it is crucial also to derive **project-specific** sustainability standards for international and bilateral **financing** institutions, and their respective private-sector counterparts.

Project-specific activities should be governed by binding rules in the long term and accompanied by **bilateral** agreements (e.g. on nature conservation, access to modern bioenergy, sustainable trade infrastructure).

Summary

To “unlock” the potential of sustainable bioenergy, it is a priority to increase the sustainability of overall biomass production for **all** bio-based products. The potential greenhouse-gas emissions arising from indirect land use change have become an issue of global concern for all biomass uses, so that an accounting approach is needed at the **global** level for all biomass and land-using products, as well as for integrating food and fuel demands.

Sustainable biomass potentials are likely to be sufficient to allow biomass to continue to play a significant role in the future global energy supply system, even if stringent sustainability requirements are to be met and demands for other bio-based products continue to grow. The cascading use of biomass which first utilizes its structural and then the heating value is key, and the decoupling of land for food and feed from that for fiber and bioenergy is the other critical component of achieving sustainable supply.

All in all, the “trilemma” of integrating biomass production with regard to food, energy and environment can be resolved without marginalizing bioenergy. A consensus on the further development of bioenergy – and biofuels as a part of that - should be possible within the boundaries of sustainability.

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Further reading: www.oeko.de/service/bio