

# Bioenergy unlimited?

## Challenges, opportunities and critical control points for a sustainable bioenergy use within the German Energiewende.

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Bioenergy is in total the most relevant renewable energy source in Germany, responsible for roughly 40 % of greenhouse gas emission reduction from renewables in 2013. The arable land which is cultivated with energy crops has been increased from about 4 % in 2003 to more than 12 % in 2013. This dramatic expansion caused debates about the additional environmental and social effects on a local, national and transnational scale, especially for land use related aspects of energy crop cultivation and use.

Research has been started to provide a deeper understanding of the systemic effects and to conclude optimization approaches and suitable management instruments. For those investigations we included the whole value chain of bioenergy utilization including land use, biomass production, biomass conversion and bioenergy use, as well as the local infrastructural, social and environmental condition. For the German bioenergy boom we analyzed the following different strengths and threats: (i) to realize positive land use effects, additional targeted management of land use might be more relevant than additional emission reduction rules; (ii) bioenergy plant locations need to consider both, biomass availability and an appropriate demand for the provided energy, (iii) the bioenergy boom initiated additional technical improvement for certain biomass conversion technologies, but their integration into the energy market needs clearer definition of the demanded qualities, (iv) the overall impact of bioenergy use strongly depends mainly on the general expectation for the further transition of the energy system and the impact of the substituted supply system, and not so much on the performance of the different bioenergy value chains; (v) on international level energy crop production has comparable lower relevance and is often coupled with feed production. International quality standards for the different bioenergy carriers currently initiate the trade with a wider range of liquid and solid biofuels and – in the longer term – also biomethane.

Our conclusion is that one major challenge for future bioenergy use is the further development of longer term visions and implementation strategies, considering two transition approaches: renewable energy supply and bioeconomy. In parallel sustainability indicators and certification schemes for all bioenergy carriers have to be

developed further, including the different dimensions of sustainability and the local and regional conditions of energy crop production.