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# Bioeconomy and sustainable development – dimensions

Economic growth coupled with environmental sustainability – that is the promise of the bio-based economy. This article outlines the potential of this approach, the possible risks and the steps that must be taken if this potential is to be realised in developing countries as well.

The German government's Bioeconomy Council defines the bioeconomy as "the knowledge-based production and use of biological resources to provide products, processes and services in all economic sectors within the frame of a sustainable economic system." The vision of a sustainable bioeconomy is the comprehensive "biologisation" of the economy, with new bio-based industrial processes and products (e.g. bio-based plastics, building materials, etc.) and changes in consumers' behaviour. Ultimately it is about a sustainable growth strategy that creates ecological and economic harmony. Biomass is an important resource for this: it will need to be produced in larger quantities and processed more efficiently. This provides employment and value-

creation opportunities for developing countries. A bioeconomy strategy will require broad-based technological and institutional innovation. Although this will need to take very different forms in industrialised and developing countries, global learning and exchange of bioeconomic innovations will become an increasingly important aspect of it, in particular in order to avoid adverse effects for food security.

### ■ What are the challenges that we face?

World population growth, climate change and the need to protect the natural environment pose major challenges. The future of humankind depends to a large extent on reliable and secure access to food, energy, water and raw materials. To safeguard access to these resources for future generations, production and consumption must be modified so that it is ecologically and socially sustainable – which it cannot be unless it is fed from renewable sources. This is where

the bioeconomy comes in. If the bioeconomy is to be realised, a nationally and internationally appropriate enabling environment must be created. In particular, the enabling environment must cover the production, use and trading of biomass, ensuring that the relevant processes are sustainable and fair. In the face of rising demand, conflicts of objectives are bound to arise. However, the appeal of the concept of the bioeconomy is that ecologically sustainable production and consumption is rewarded with technological and economic opportunities. New complementarities emerge, but also competitions. For example, in an inappropriately designed bioeconomy food security may be adversely affected, while economic efficiency and sustainability may be increased. What is needed is therefore holistic consideration of synergies between biomass production, new technologies for processing biomass, and new links within and between value chains, in particular in connection with the manufacture of biofuels and bio-based chemicals and the use of the residues of bio-based

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products in the chemical and construction materials industries. The risks of the bioeconomy must be countered with increased investment in research and technology and the development of markets.

### ■ The drivers

Fossil fuels formed the foundation of economic growth and have underpinned development since the industrial revolution. Today, the bioeconomy is about significantly more than the substitution of energy resources. Its opportunities lie in the refining of products, giving rise to completely new product lines for the end consumer, and in new, efficient processes.

The vision behind the bioeconomy is therefore that of an efficient use of bio-based resources, new technological opportunities and altered patterns of consumption, especially in the wealthy countries. A coordinated and long-term bioeconomy policy that considers emerging changes of prices, fosters technological innovation and develops demand is a key driver of the bioeconomy. New products come with the promise of being more natural, healthier and more sustainable. They are being advanced by numerous manufacturers of consumer goods who promote appropriate products and bio-based processes and packaging. In addition, climate change makes investment in the bioeconomy attractive: firstly, because it is necessary to put the energy supply on a new foot-

ing that can include biomass to some extent; secondly, because of the need to counter the impending risk of falling crop harvests; and thirdly because markets for greenhouse gas emission rights could in future increase the incentive for biomass stocks for carbon capture to de-carbonise the atmosphere.

### ■ International trends

The bioeconomy is not an example of sudden hype but has developed gradually. The concept was first defined in 1997 by Juan Enríquez-Cabot and Rodrigo Martínez. As leading international organisations, the OECD and the EU were quick to recognise the potential of the bioeconomy. In Europe the idea of a bio-based economy has been debated since the late 1990s. The concept of a knowledge-based bioeconomy was first officially introduced in 2005 by Janez Potočnik, then the European Commissioner for the Environment. Under Germany's presidency of the EU Council it was taken further with the Cologne Declaration. Under the title "En route to the bio-based economy" the focus shifted to food, biomaterials, bioprocesses, bioenergy and biomedicine. The EU and Germany – as a pioneer at national level – adopted clear strategies to promote the bioeconomy (see also the articles on pages 10–15). In 2009 the German government convened a council of political and scientific experts, the Bioeconomy Council, which advises policy-makers on issues relating to the bioeconomy. In the last

five years a large number of countries – most of them industrialised nations but including some newly industrialising ones – have drawn up bioeconomy strategies and incorporated them into their scientific and economic policy at national level (see pages 10–13). All the G7 and many of the G20 states are now including the bioeconomy in their economic strategies. The key arguments in this debate are as follows:

- The bioeconomy is driven by shifts in the prices of resources and the factors of production (land and labour; energy) and by associated price structures, as well as by technological opportunities and altered consumer preferences.
- The bioeconomy provides opportunities for employment, income generation and investment in agriculture worldwide. At the same time, though, there is a risk of exacerbating the scarcity of biomass. Biomass-based products compete with the supply of food. This could have particularly adverse effects on the poor unless new technologies ensure that possible scarcities are compensated or, if possible, overcompensated for, or unless social protection mechanisms are expanded.

### ■ Potentials

The bioeconomy enables economic growth to be combined with ecological sustainability. It is therefore a core element of sustainability concepts such as the "green economy".

It is estimated that a systematic shift to cultivated biomass and biological production processes could cut CO<sub>2</sub> emissions in Europe by up to 2.5 billion tonnes per year. Some 13 billion tonnes of biomass are available globally. Around 60 per cent of this is used for animal feed, 15 per cent for food and 25 per cent for energy or as an industrial feedstock. The most important bio-based industrial products are (currently) specialty chemicals, plastics and composites, surfactants, lacquers and paints, lubricants, paper and cellulose, building materials, furniture and pharmaceuticals. The most important energy products are biogas and biofuels. Technological progress, especially in the life sciences, is expected to lead to the development of new products that combine sustainability with increased consumer utility. Important companies in the bioeconomy are Novozymes (biotechnology, Denmark), DSM (chemicals, Netherlands), Cargill and DuPont (chemicals, USA), and also large food companies (Nestlé, Switzerland). In Germany chemical companies such as BASF, Süd-Chemie, Evonik and Symrise (flavourings) and Continental (automotive parts) are prominent in the field.

Innovation is often driven by research-oriented small and medium-sized biotechnology companies. In Germany about 12.5 per cent of the workforce depends on businesses that can be classed as part of the bioeconomy. They generate around 7.6 per cent of gross value added in Germany. Twelve per cent of value creation in the bioeconomy takes place in the primary sector (agriculture and forestry), 52 per cent in the secondary sector (processing) and 36 per cent in the tertiary sector (trade and services). Key areas include the energy industry – 7.6 per cent of energy consumption is met from cultivated biomass – and the chemical industry: 13 per cent of the resources processed in this sector are bio-based. Many bio-based products are already on the market or in preparation. The bioeconomy embraces all sectors, penetrating the entire economy: in this respect it is comparable to information and communication technology. This means that there are

a vast number of interwoven value chains with biomass as their starting point; the task is to optimise this value creation network.

### ■ Food security policy in the context of the bioeconomy

Uncertainties in the food and nutritional situation imperil the prospects of the poor, especially in low-income countries. The bioeconomy must above all promote food security. The advantages and disadvantages of the bioeconomy in relation to food security must be considered from at least two angles – firstly, competition in related markets and the resulting impact on prices, and secondly the synergies that arise from the use of technology related to the bioeconomy and food security and that affect the income situation of the poor.

It is likely that the demand for biomass will rise not only as a result of world population growth but also because of the rising demand for biomass for industrial and material uses. The bioeconomy alters the balance of the global food situation: it does this on both the supply and the demand side and so may affect food security. On account of this there has been much debate about solutions to the “food/fuel/feed” competition problem. The fol-

lowing usage priorities, the “5F”, are now generally accepted: food, feed, fibre, fuel, forests. In other words, biomass should first be used to feed people before it is used as animal feed, as a raw material for industry or for energy in the form of fuel. Where possible, use should be cascaded, following the 5F sequence of priorities (see article on pages 28–29). New scientific concepts are needed to enable conflicts of objectives that arise to be resolved with the help of technology, organisational innovation and trade.

The linkages between biofuels and food security are evidenced not only in commodity market trends, with rising prices for agricultural products such as cereals, but also in the markets for land and water. The sharp increase in land acquisitions, in part for the purpose of growing biofuels, demonstrates that the strong demand for biomass has become an international issue. In the often non-transparent markets for land ownership, in which power is usually more important than efficiency, more must be done to protect the rights of poor landowners in dealings with investors, especially in the case of small farmers and nomadic pastoralists.

The link with food security shows that new key areas of the bioeconomy are emerging in terms of influencing market development and technologi-

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Photo: J. Boethling

cal progress. For example, sugar and maize crops will not enable sufficient bioethanol to be produced to meet climate and energy targets. Hopes are being pinned on the use of lignocellulosic biomass that is not suitable for human or animal consumption from sites that cannot be used for food production. However, developing efficient extraction processes for lignocellulose will take some time.

Cotton is currently the most commonly used fibre. However, growing cotton requires large quantities of water and fertiliser. In many places, flax and hemp fibres could be produced more efficiently. Plant breeding plays a key part in the development of a sustainable bioeconomy. It can, for example, increase the efficiency of agricultural production and extend the natural range of resources – as in the case of new plant oils containing different fatty acid profiles, which can simplify the refining and chemical modification of the oil in industry. In such contexts biotechnology is a key method for achieving targets such as product quality, increased yield, greater resistance to disease or wider usefulness of by-products.

Viewed as a whole, the bioeconomy changes the competitive situation in relation to food, land and water. Bioeconomy systems that do not put pressure on food security require new types of biomass, multi-tier recovery systems and innovation throughout the value chain. The growing market for biomass and its agricultural basis require a reliable setting for sustainable production and processing.

### ■ Enabling the developing world to benefit too: shaping the bioeconomy

The less-developed states have in the past played little part in global value creation. Because they are relatively rich in biomass potential, the bioeconomy could change this. For the future, solutions will therefore be needed that combine economic growth with global responsibility for worldwide nutrition, protection of the environment

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and climate change mitigation. Unlike oil, gas or coal, biomass is distributed widely across the planet. Developing countries, in particular, have large quantities of renewable biological resources. Provided that cultivation and processing are carried out responsibly, fairly and in accordance with internationally defined social and sustainability standards, these natural resources can be tapped. When correctly organised, a bio-based economic system is therefore able to strengthen the economy of developing countries, create jobs and feed a growing world population. Through its knowledge-based approach the bioeconomy can create the basis for new, fair business partnerships between industrialised and developing countries and remove past conflicts of interest. Industrialised countries want access to biomass resources. Wherever possible, these resources should be processed in developing countries in order to increase value creation there.

In an implicit process of exchange, developing countries should gain greater access to new bioeconomy technologies and related science from industrialised countries. This requires increased co-operation in research partnerships in the public and private sectors. This would give developing countries the opportunity to play an increasingly large part in value creation. In the con-

text of a sustainable economic policy the bioeconomy can thus become a driver of progress and social change – cutting across the present-day rich/poor divide.

As part of far-reaching changes, the bioeconomy should be viewed as social, technological and economic transformation – that is, sustainable transformation – of the economic system. The core of these transformation strategies is not confined to the dimension of technology (novel science) but includes behaviour change (modified consumption) and institutional innovations for enabling settings and long-term incentives, at the level both of companies and of international policy. Internationally harmonised settings enable the potential of the bioeconomy for industrialised, emerging and developing countries to be realised; in other words, they enable the production and use of and open trade in biomass to be regulated fairly. Smart bioeconomy is at the heart of sustainable economic development. For the next generation of scientists, inventors, small and medium-sized enterprises, farmers, and eco and social entrepreneurs it is both a challenge and an opportunity.

References and sources for further reading: > [www.rural21.com](http://www.rural21.com)