

Wood-based Bioeconomy

Sustainable, Circular, Climate-resilient

acatech (Ed.)



What role can innovative wood-based technologies and products play in the implementation and development of a sustainable, circular and climate-resilient bioeconomy in Germany? This acatech POSITION PAPER considers this question, using specific examples, and aims to identify enabling factors and obstacles and to derive recommendations for a wood-based bioeconomy.

The publication focuses on the utilisation of wood, a renewable resource, and specifically on its use as a material. The use of wood as a material has advantages over the immediate use of wood for energy purposes. Using wood as a material for as long as possible and multiple times (known as cascading use) contributes in particular towards climate protection (CO₂ storage capacity) as well as to resource efficiency, and is often associated with greater added value than the use of wood for energy purposes. The use of wood for energy purposes is therefore mentioned only briefly in this publication.

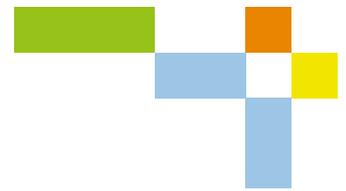
The concept of the bioeconomy has been part of German and international strategies and policies for some time now. The term bioeconomy is generally understood to mean the production, exploitation and use of biological resources, processes and systems in order to provide products, techniques and services for sustainable practices that make the connection between ecology and the economy. It involves the use of raw materials from agriculture, forestry and the maritime economy, the fishing industry and aquaculture or microbial production, plus biogenic residual and waste materials, as well as knowledge of biological processes and systems. The bioeconomy can support the implementation of the United Nations Sustainable Development Goals (SDGs), especially climate protection and resource conservation, provided that the biomass required is produced with due regard for environmental and social criteria and is used efficiently.

Along with agriculture, the most important producer of plant-based, terrestrial raw materials in the world is forestry. The wood-based bioeconomy is a substantial segment of the

bioeconomy and comprises both the use of wood as a material and the use of wood for energy purposes. The use of wood as a material has a long tradition and numerous advantages. Durable wood products, such as those used in timber construction, store the greenhouse gas carbon dioxide. Reusing the wood as a material multiple times prolongs the storage period. In addition, wood products can replace energy-intensive products made with fossil fuels, thereby contributing to emission reductions. Already today, half the raw material wood comes from forests (primary raw material) and half from secondary raw materials.

Germany has a large area of forest, a leading position in Europe in the wood industry and in mechanical engineering, and a diverse scientific and research landscape, all of which provide a good foundation for the ongoing development of the wood-based bioeconomy in Germany. The key to increasing the innovation potential of a wood-based bioeconomy in a sustainable and viable manner will be paying equal attention to environmental, economic and social requirements and finding the balance between them. Climate change, the lack of availability of raw materials, disrupted supply chains and global upheavals affecting virtually all economic sectors highlight the need to reconcile these different demands.

Against this backdrop, this acatech POSITION PAPER adopts a systematic perspective. An attempt is made to provide some context, as different stakeholders have different expectations of the forest, with a trade-off required between its protection and its use. Besides its function as a supplier of raw materials, the forest is also a place of recreation and of cultural value. Moreover, it provides other ecosystem services that are important for environmental, biodiversity and climate protection, as well as for regulation of the water balance and for erosion control. Its carbon storage function (as a CO₂ sink) is reflected in the German Climate Change Act as well as in various EU strategies and this will help achieve climate goals and climate neutrality through negative CO₂ emissions. However, the forest itself is affected by the consequences of climate change, as can be seen,



At a glance

- This publication focuses on the contribution made to the economy, the environment and society by the use of wood as a material. It looks at innovations in areas such as the construction, transport and packaging sectors, as well as in the chemical industry, and makes recommendations as a result.
- A limiting factor is the availability of the raw material. Forests provide not only wood but also other ecosystem services – climate and biodiversity protection and recreational spaces for humans – and are themselves affected by climate change. Climate-adapted forest management and active climate protection policies are therefore essential. Given supply chain issues and increasing competition for resources, efficient use of fresh wood and secondary raw materials is also important.
- A sustainable wood-based bioeconomy aims to decouple economic growth and the consumption of raw materials, and is a key element in a circular economy. It is important to use wood products for as long as possible and multiple times (cascading use) and to recycle them into products with high added value.
- Policymakers should adopt measures that more strongly prioritise and codify the use of wood as a material. It is also recommended that the use of wood for energy purposes should be confined to timber product lines that cannot be reused as materials. The development of a sustainable biomass strategy would also be helpful here. The public sector should take greater account of sustainability criteria when inviting tenders. When developing products, companies must apply the „Design for reuse and recycling“ principle from the outset and also offer repair and leasing services. Moreover, wider social involvement is required, so that conflicting objectives can be discussed at an early stage.

for example, from damage caused to forests between 2018 and 2020 by heat, drought, storms, fires or insect infestation, with the result that the forest becomes a carbon source in some regions.

Climate-adapted forest restructuring entails a higher proportion of deciduous trees and a greater diversity of tree species but takes several decades to achieve. A greater diversity of tree species enhances biodiversity and contributes towards the forest becoming more resilient, due to the different characteristics of the various species. Protected unmanaged forests are important in terms of nature conservation and species protection, as well as for acquiring knowledge about tree species that are shown to be more resilient and better adapted to the climate. At the same time, various policies are highlighting the contribution to climate protection made by durable wood products, especially in timber construction. To ensure the balance between protection and use, equal attention should be paid to the objectives of a wood-based bioeconomy and to biodiversity and climate protection.

Wood is internationally traded. Its price is subject to fluctuations, based on supply and demand. Falling imports and increasing exports of wood and growing competition for (land) use may result in reduced availability of the raw material within Germany. Greater national and international demand results in shortages of primary and secondary raw materials, depending on the timescale. This is reflected, inter alia, in rising prices and planning uncertainty. What is often seen as an obstacle can, however, also be an opportunity for innovation and new market players. Resource efficiency and resource productivity are important drivers of innovation.

The wood-based bioeconomy is therefore both a partner and a key element in a circular economy, which is increasingly becoming a gamechanger for companies given the issue of availability of raw materials. Moreover, accelerated digitalisation and collaborations are promoting innovative technologies and may lead to more rapid application in pilot projects all the way to market. Already today, cross-sector cooperation is taking place in value creation networks between, for example, the traditional wood industry and the transport and chemical sectors. The result of such cooperation is often higher-quality products that go beyond a simple one-for-one substitution of products based on fossil fuels and can generate additional value added for customers and for the environment which, in turn, can contribute towards the creation of skilled jobs.



For the implementation and expansion of a wood-based bioeconomy that is sustainable, circular and climate-resilient, acatech makes the following recommendations. These are grouped into five action areas and addressed to decision-makers in politics, business, society and science.

Securing the primary raw material base in the long term: Rewarding sustainable forest management

Having regard to specific regional characteristics, the aim should be to convert forests into climate-adapted mixed forests. These should also comprise an appropriate proportion of coniferous trees to enable the production of numerous wood products, especially those which are durable, to continue in the medium and long term.

Outside protected zones, the aim should be integrative forest management (which provides in equal measure for conservation and production) over the largest possible area.

The positive impact and benefits of the forest (including CO₂ storage, but also recreation and biodiversity) should be internalised, for efficiency reasons among other things. In future, therefore, forest owners should receive income not only from the sale of wood but also from the ecosystem services provided by the forest for the general public and in compliance with government contracts and agreements, especially as this is often associated with additional costs. A results-driven graduated reward of this kind, financed by the public sector, should be designed for the long term and oriented towards the adaptability and increased resilience of the forest. Therefore it will be necessary to devise scientifically based indicators that would pay equal attention to the sustainable supply of raw materials, the climate protection effect and biological diversity.

To identify damaging events at an early stage and secure the primary raw material base in terms of quantity and quality, it is recommended that digital forest monitoring be expanded. Such systems will increasingly need to use remote sensing technology, such as satellites and drones.

Using wood sparingly and efficiently: Strengthening the circular economy and cascading use

Implementing the circular economy. The raw material wood should be used as efficiently as possible. This applies to both the primary and the secondary raw material. So not only the

whole tree but also timber from forest thinning and wood derived from agricultural production and from landscape conservation measures should be utilised and their constituent parts should be used as materials for as long as possible. In addition, there is a need to increase the quantitative and qualitative availability of secondary raw materials such as waste paper and waste wood through recycling and cascading use (i. e. by using them as high-quality materials as often as possible), partly in order to contribute towards climate protection through an extended period of CO₂ storage. By-products and co-products arising should also be processed.

To promote cascading use, the range of waste wood and products that can be used as materials needs to be more clearly prioritised over their use for energy purposes. Even if this order of priority is already enshrined in the German Circular Economy Act (KrWG), using wood as a material multiple times (cascading use) should be explicitly laid down in a separate regulation. In addition, cascading use could be further promoted through a Germany-wide cross-sector ideas competition (that might focus for example on "Long Life – Wood as a Carbon Store") or through research projects on the theme of upcycling.

Recycling waste wood. In the forthcoming amendment of the German Waste Wood Ordinance, it should be stipulated that the use of wood as a material should have priority in those waste wood categories that are suitable. Currently, construction and demolition waste wood is often burnt in waste wood incinerators, due to the suspicion that it might contain pollutants. Instead, the focus should be on exploiting its recycling potential by adopting appropriate measures including separate collection, practical process-related sampling techniques and statistical analysis. In addition, employees in companies that treat waste wood should be given appropriate training. As waste wood is traded internationally, regulations relating to its quality, collection, treatment and analysis need to be harmonised across Europe.

Using wood for energy purposes should only happen in the final stage of each cascade and should be limited to product lines that are non-recyclable and cannot be used as materials. The only biomass plants that should be permitted in the future are those that are flexible, adjustable and highly-efficient (cogeneration plants for the production of electricity). From a systems perspective, these plants, by providing storage, act as a complement to plants based on renewable energy systems (photovoltaic and wind power plants) with their fluctuating output and to the heat pumps that they power.



“Design for reuse and recycling.” From the very beginning of the product development process, companies should incorporate the concept of “design for reuse and recycling”. To do so, they should share ideas with participants in cross-sector value creation networks and also provide data. Using information and marketing, companies should seek to increase acceptance of quality-assured secondary raw materials being incorporated into products and of recycled products. In addition, it is worth considering the introduction of certification in the form of a recycling logo for materials of biogenic origin.

Increasing the acceptance of innovative wood-based applications where wood is used as a material: Providing transparent information and optimising eligibility for state support

Ecobalances and Life Cycle Assessments (LCAs). Transparent information is the prerequisite for the approval and granting of support for innovative, recyclable and potentially more expensive wood-based products and services. Ecobalances and Life Cycle Assessments (LCAs) can make a significant contribution here, as they enable a comparison to be made between products, manufacturing processes and components with regard to various sustainability criteria. To meet this objective, LCAs need to be practical, comparable and transparent. They should reflect not only the product’s carbon footprint but preferably also other environmental, social and economic effects over the entire life cycle of the product. More research and standardisation will be required to do this.

Appeal to customers. Greater demand from customers for recyclable products (a pull factor) may contribute towards resource efficiency in the same way as the corresponding offer from companies (a push factor).

The willingness of market players to pay more for this if necessary is expected to increase, if they are able to perceive added value for the environment or for social interests or an additional benefit in terms of function. For this reason, companies should provide their customers with tailored, transparent information about their products and services, while at the same time avoiding information overload. This information can be provided in different formats, including QR codes, marketing initiatives and recycling logos. Added value can also be generated if less of the product is consumed or the product is more durable, or as a result of leasing and sharing options. Companies should therefore provide their customers with take-back offers, supplies of spare

parts and repair services, or they should guarantee that these will be available.

The public sector as a role model and eligibility for state support. When awarding contracts, the public sector should set a much better example. Tenders should be invited and contracts awarded in a material-neutral and functional way, taking into account sustainability criteria with regard to climate protection and climate neutrality. Aspects to consider include whether the requirements of the German Sustainable Construction Quality Seal (QNG) could become mandatory for public tenders for new buildings, as is already the case for the granting of certain loans by KfW, the German state-owned investment and development bank. This quality seal comprises environmental, sociocultural and economic criteria for buildings. Since Spring 2022, state-subsidised loans have only been granted for new buildings if they can produce this QNG certification.

From 2023, the German Government has a plan for a new “Climate-Friendly Construction” programme that will take greater account of greenhouse gas (GHG) emissions in the life cycle of buildings.

It would be advisable to make the granting of government support, as a matter of principle, conditional on compliance with climate protection and scientifically-based sustainability criteria: for example, by setting an upper limit for GHG emissions per square metre of usable floor or living space in new buildings. This would be of benefit to timber construction due to its CO₂ storage capacity.

Establishing innovative wood-based applications where wood is used as a material: Continuing to develop governance and the (legal) framework in a coherent manner

Coherent governance. The implementation of a (wood-based) bioeconomy may give rise to conflicts of interest or situations where problems are moved to other parts of the world (such as changes in land use and social factors). Current crises and developments have also revealed the impact of disruption to supply chains. Coherent governance and cross-departmental national and international cooperation are necessary in order to develop resilient strategies based on common goals. A biomass strategy should be devised for Germany which involves the German federal states and stakeholders in society, setting out competing uses and establishing priorities as a result. There should be a call



on the EU to do the same. Creating a level playing field between the use of wood as a material and its use for energy purposes is the first step towards removing the specific incentives that have existed to date for the use of wood for energy purposes, such as the German Renewable Energy Sources Act (EEG), the German Buildings Energy Act (GEG) and market incentive programmes for renewable energy. In the heating sector, in particular, there is a need to act quickly on this issue. These incentives should be replaced in the future with CO₂ pricing for all sectors that is as uniform as possible. The crucial factor here is that the CO₂ price is an integral part of an ambitious climate policy.

Congruent legislation. In the area of timber construction, regulations should be adapted to take account of the latest developments in science and technology. This applies in particular to the adoption of timber panel construction in multi-storey buildings in building class 5. Furthermore, there is congestion in the standardisation process and the draft of the revised EU Construction Products Regulation is just the first step towards its resolution. The importance of the harmonisation of specifications at European level can be seen, for example, from the issue of volatile organic compounds (VOCs). A level playing field with regard to technical requirements is essential for a Europe-wide wood-based bioeconomy.

Meeting future requirements and conditions: Generating innovative business models, involving society, scrutinising patterns of consumption, incentivising education and training as well as research

Generating innovative business models. For a wood-based bioeconomy and circular economy, there is a need for working and thinking in value creation networks (i.e. cooperating with other sectors outside the wood industry). Digitalisation can make a significant contribution here, enabling the relevant players to interact and exchange data via platforms. It can provide support for simulations, standardisation, and appropriate customised manufacture, supply and tracking of products, as well as for communication with customers, planners and authorities. Examples of this include the creation of digital product passports and Building Information Modeling (BIM) in the construction sector.

New business models also require investment in plant and machinery. To help reduce the financial outlay required, especially for the small and medium-sized enterprises (SMEs) that make up much of the German wood industry, businesses can cooperate with each other, perhaps by sharing the use of plant. Unbureaucratic support

is also required to help artisans and SMEs with digitalisation, automation and knowledge transfer. This could produce a type of "industrialised craft", applying digital solutions to exploit the various characteristics of wood for small-scale applications. In addition, start-ups should be supported by the provision of venture capital. Artisans, SMEs and regional wealth creation would probably all benefit from IT and high-tech companies especially in rural locations.

Involving society and scrutinising patterns of consumption. The concept of the bioeconomy elicits different views and expectations. For some, the bioeconomy can contribute towards prosperity and job security, while others see it as carrying on as usual, only with a "green" growth model. To arrive at a common understanding and discuss conflicting aims in a wider social context, there is a need for continuing civic dialogue on the bioeconomy involving the German Bioeconomy Council. In addition, patterns of consumption should be scrutinised, and behavioural changes will play a role here. A more conscious approach to consumption and lower levels of consumption (reduce, repair, reuse, recycle) take account of the planet's environmental limits, contribute towards resource conservation and are important elements of a circular economy.

Sharing knowledge between regions. The review of the selected model regions (Baden-Württemberg, Bavaria, Saxony and Saxony-Anhalt) illustrates the fact that the German federal states can build on the experience of the other states. This applies, for instance, to the marketing of wood products, timber construction initiatives and the development of strategies, meaning that measures should be specifically adapted to regional circumstances and strengths. This explains why, for example, biorefinery concepts are realised in Central Germany (Saxony, Thuringia and Saxony-Anhalt), an area where the chemical industry has had a significant impact. However, it is also possible to learn from others at an international level and through cultural exchanges. Regions around the world from which German regions might learn include Scandinavia, Austria, Switzerland, North America and Asia, areas where timber construction is already more widespread.

Education and training, research, knowledge transfer and securing skilled personnel. There is an urgent need for pupils to learn about wood at school, especially about its exploitation and use. Further education and training for professionals such as architects and civil engineers as well as for skilled crafts, especially in timber construction, should be stepped up, drawing on the



experience of other regions. It would also be expedient to adopt an interdisciplinary approach to university and non-university education and apprenticeships, while still retaining a certain level of specialisation. The promotion of digital expertise and creativity is essential and these subjects must form an integral part of any education. In light of the discussion about sovereignty and sufficiency, research projects should be launched to examine potential changes in behaviour and consumption patterns. Sufficiency here need not necessarily be equated with sacrifice, but rather with making various options possible.

The growing shortage of skilled labour in the forestry and wood industry – partly as a result of demographic trends and the exodus of qualified woodworkers into better paid industry sectors – needs to be addressed by offering adequate remuneration and, in the case of migrant skilled workers, with unbureaucratic recognition procedures for qualifications. Companies and associations need to attract skilled workers by conducting image campaigns that target specific groups and by making attractive offers.

Methodological approach

This acatech POSITION PAPER focuses on the contribution to the economy, the environment and society that can be made by using wood as a material, and looks at innovative wood-based technologies, products and services. In addition to the traditional exploitation of wood, the POSITION PAPER considers other sectors such as the chemical, transport and packaging industries, as well as presenting examples from the German federal states of Baden-Württemberg, Bavaria, Saxony and Saxony-Anhalt. The results and recommendations are based on the evaluation of publications, studies and commentaries, as well as of two sub-assignments covering special subjects. The paper was prepared mainly from the exchange of ideas within the project group. Discussions also took place in four moderated workshops and in virtual project group meetings between the members of the project group and invited experts from science and business and from associations and non-governmental organisations (NGOs) about potential drivers of innovation and obstacles to innovation along the wood value chain.

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