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Monitoring Bioeconomy

SYMOBIO

Wood in Focus

INNOVATION POTENTIALS, RISKS AND MEASURES TO GET THE CIRCULAR BIOECONOMY IN GERMANY RIGHT

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*Scyscrapers, sportswear, cosmetics and high-tech dashboards – all made from wood. Free of microplastics and more water and carbon-efficient than alternatives, these examples showcase the versatility and potentials of wood for transforming Germany's economy into a bioeconomy. However, this potential **depends on how** the bioeconomy is implemented. **Measures** are needed to ensure that demands do not outpace the capacities of both German and global forests to supply the bioeconomy with wood, while also providing habitats for wild species, absorbing carbon dioxide and protecting water cycles. It requires finding a balance between how much wood is extracted, processed and consumed and how much is "reserved" for nature – from which we also depend. Monitoring from a **systemic perspective** helps to understand and evaluate the development of the bioeconomy and its resource base. Evidence on the potentials and risks – like those shown here – provide the **impetus for policy** to act, especially to support **technical and social innovation** toward developing a sustainable and circular bioeconomy. Seven key policy messagesare presented.*

1

million people employed*[1]

115

thousand campanies*[1]

Storing the equivalent of

7%

of Germany's annual GHG emissions**[2]

Home to nearly

3,000

plant species[5]

The traditional forestry and wood-based product sectors in Germany are **relevant contributors** to employment and gross value added (€56 billion in 2019), especially in rural areas[1]. Germany's forest is also critical to halting climate change. Forests were estimated to absorb around 56 million tonnes of CO_2 per year (in e.g. 2017)[2,3]. At the same time, using wood to replace more energy and resource intensive resources (like concrete by building with wood) is often associated with climate benefits[4] – at a product scale. This raises the question: What is the optimal **balance** between harvesting wood (to substitute more CO_2-intensive feedstocks) versus maintaining and managing forest ecosystems as a **carbon sink?** On a globally connected planet, this question is not only relevant for national forests, but also for imports.

The inspiring Innovations that have us excited about the potential of wood in the bioeconomy **will not just happen** in a sustainable way, unless primary wood demands are **monitored**, and **reduced** when needed (e.g. by cutting wasteful, excessive and inefficient consumption).

Relevance of forest and wood product markets

*In forestry and wood industry sectors[1]

Corresponding to an estimated 62 Mt CO_2 per year. This is based on two "sinks": 1. sequestered by German forests (56 Mt CO_2 **comprising 90%) and 2. Estimated as stored in wood-based products (ca. 6 Mt CO_2 **comprising 10%**)[2] . Data refer to an average for 2016-2020[2], but significant forest disturbances (drought and die-back) not yet included in the accounting may signifiantly underestimate the forest sink for the years 2018-2020[3], underscoring the urgent need to better protect and manage forests for their provision of ecosystem services.

A stable and sustainable long-term supply outlook is needed to **get the signals for investment "right"** today. It is those investments that will either power or hinder tomorrow's innovations.

that requires

Monitoring the state of forests, production volumes and capacities, as well as consumption levels.

Footprints provide the tools for the latter.

they deliver

A needed perspective to **navigate the challenges**: Ensuring that the innovative potentials of the bio-economy (page 3) can be met without exacerbating the risks (page 4).

State of German Forests

Forests cover around
one-third
of Germany's territory[6]

Nearly **30%** of forests are classified as close-to-nature[8]

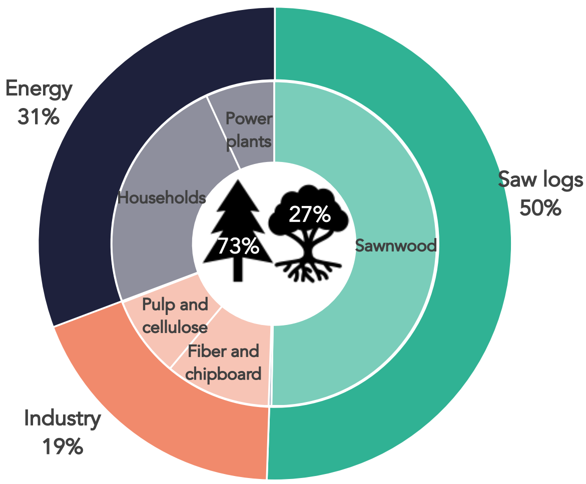
Just **4 species** cover nearly ¾ of German forests (spruce, pine, beach and oak)[6]

Insects, storms, heat and drought caused more than
€12.7 billion
in damages (2018–2020)[9]

Around ¼ of German forests are
monocultures[7]

75% of wood removals in 2020 comprised salvage logging (due in particular to drought and insect damage impacting **conifers**)[10]

Current uses of wood



Domestic use of wood in Germany, 2017[11]

More than **90%** of saw logs and around ¾ of industry wood is comprised of
conifers,
whereas most energy wood is comprised of deciduous species (62%)[11]. This has technical reasons[12], but innovation can support a shift[12].

Innovative potentials to transform wood markets

German forest Harz.

Innovative business models

Focused on creating value for community, business model innovation is at the heart of a socio-economic transformation. It includes concepts like **design for re-use and recycling** (e.g. modular design in construction), **selling functionality** (e.g. leasing schemes for office furniture or re-usable cups for coffee to-go), and digitalization (e.g. digital product passports). **Co-operation** across sectors and with customers is needed, as well as skills training and know-how (in low and high-skill areas). It requires not only greater corporate responsibility and redefined metrics of success, but also the development of **networks**, growth in research (interdisciplinary, industry 4.0) and stronger public awareness[13].

An engaged & willing populace – reduce, re-use, recycle

Around 10.3 million tonnes of waste wood were collected in Germany in 2020[14]. The majority (around 70%) is burned directly for energy, mostly in large firing systems. Particleboard production is the largest industrial application[14]. Product design (for ease and high-quality recycling) as well as collection and separation of waste wood streams are critical **enablers** of the circular bioeconomy. Deeper socio-economic transformation requires citizen mobilisation that also includes social and grassroots innovations addressing what, how and how much wood is consumed. Some examples have become mainstream (e.g. exchange platforms for used goods) while others are gaining traction (e.g. collaborative consumption and the **sharing economy** for e.g. outdoor furniture, books, toys, space & tools).

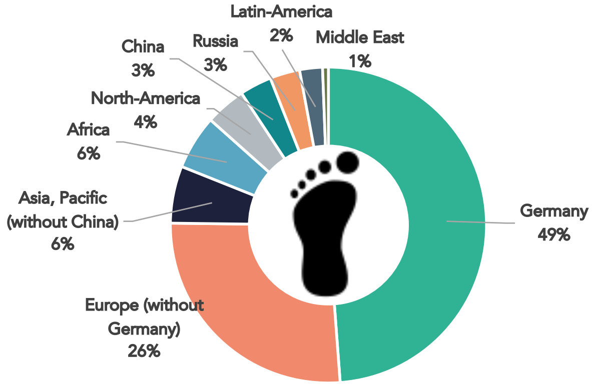
New markets

From mass timber products in construction to non-toxic binders in the chemical sector, new applications, products and markets are emerging for wood-based products[13]. This can impact demands for wood species and quality requirements. There are at least 139 **biorefineries** in Europe using forest-based feed-stocks[15]. While most focus on existing markets (pulp), large research and development investments have generated high expectations (e.g. on the substitution potential of **lignin**). High tech applications are increasing material efficiency (like the use of robots in wooden construction). Greater mobilisation of recycling streams may also create new opportunities. For example, the Circular Economy Act[16] requires separate collection of textile waste starting in 2025, and could open new possibilities for **up/recycling**.

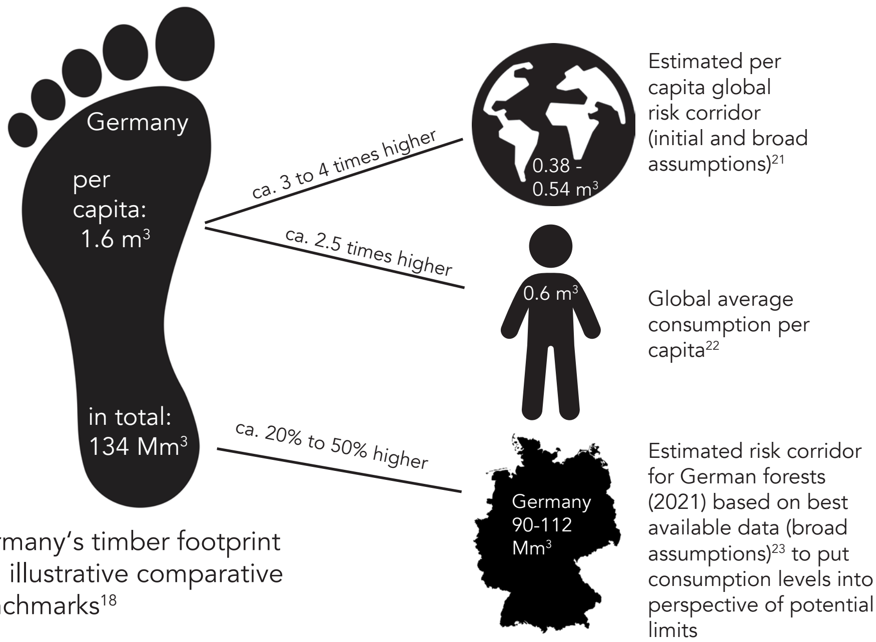
Risks

Overconsumption could devastate biodiversity and add to climate change
Already today, Germany's timber consumption footprint is higher than the quantity that can be sustainably harvested from Germany's forests on an annual basis[17]. There is a risk of increasing imports at levels that overburden the global forest area, both in terms of ecosystem integrity and fair distribution[18]. What and how much pressure is judged acceptable in the **trade-off** between supply and conservation should be addressed within society. Initial results on a planetary boundary for wood consumption – considering in particular the need to counteract the **6th mass extinction**[19] through protection, community conservation and multi-purpose forestry – show that global production and consumption are **exceeding** the estimated risk corridor for a sustainable consumption benchmark[18].

How much primary wood does Germany consume and how sustainable is it?



Composition of the German timber footprint 2021, roundwood equivalents[17]



Germany's timber footprint and illustrative comparative benchmarks[18]

> The German timber consumption footprint was 134 million cubic meters (Mm³) over bark in 2021[17]. It accounts for the primary flows sourced from forests (with the aim of indicating pressures on ecosystems) and excludes secondary flows sourced from the economy (which are monitored by complementary approaches[20]). Around half of the primary wood consumed in Germany is imported[17]. Germany also exports large amounts (around one-third of removals in 2021)[18].

High demands can make illegal activities more attractive
15 to 30% of globally traded wood volumes are estimated to be obtained illegally[24]. Forestry crimes (including illegal logging and deforestation) have been described as "the **single greatest threat** to life on the planet, eradicating more species and numbers than any other human activity"[25]. A vast **mismatch** between enforcement capacities and potential profits can make crime in the forestry sector attractive. Increased timber demands could provide further incentives for illegal logging, unless significant and widespread efforts are put into combatting such crimes.

Rebounds and lock-ins (energy use preferred to material use) could set-back efficiency gains
This is a risk across forest production (e.g. highly efficient plantations producing cheaper timber make plantation expansion more attractive) and consumption (e.g. digitalization may have decreased paper use in Germany, but online shopping has raised the need for packaging[4]). Making sure that technological innovation contributes to reaching sustainability goals requires **accompanying measures** on institutional and social change.

Similarly, risks associated with path dependencies should be considered before implementing market-based instruments. This could be the case, when e.g. the demand for by-products like sawdust outpaces the demands for sawnwood. It is particularly relevant for the growing **competition** between energetic and material uses of wood and waste wood (e.g. sawdust for pellets versus industrial uses – e.g. in composite wood products and particleboard).

Tipping the scales: Getting investments in forest restoration and plantations wrong
There is a lot of excitement, energy and empowerment in tree planting pledges across the world. Commitments made – in e.g. the Bonn Challenge, the New York Declaration on Forests, and the EU's Green Deal – emphasize the role of forest landscape restoration to regain ecological functionality and enhance human well-being. There are also good opportunities for **co-benefits**, like sequestering carbon and producing timber. However, achievements so far are behind targets and nearly half of the restoration efforts in one 2019 study revealed a tendency toward establishing monoculture plantations[26]. Adjusting expectations for investments to **align priorities** with capacities is needed to get restoration right[27].

Policy measures

1. Account for an include timber consumption footprints in official monitoring statistics

Footprints establish the evidence base for implementing policies targeting wood consumption. They are used to capture and communicate the burdens of consumption abroad. As national footprints address the scale of consumption, they may be used to **frame social discussions** on what and how waste, excess and sufficiency are defined. They complement sustainability metrics across multiple scales (e.g. certification, life-cycle assessment, earth system modelling and statistics on e.g. fellings and uses of roundwood) to provide a **systemic perspective**[28].

2. Set benchmarks for sustainable consumption

Just as harvest quotas are used to ensure sustainable levels of production, guardrails are needed to know how much wood can be consumed without contributing to overburdening national and global forests[18]. Benchmarks are comparative indicators used to relate consumption levels with sustainable supply capacities (such as a "safe and just corridor for people and the planet"[29]). For forestry, they **link** wood consumption to the biodiversity and climate crisis. Such benchmarks must be further developed, in a social discourse and based on best available scientific evidence.

3. Invest in further developing monitoring tools and promote their application (e.g. by business)

Footprint tools can be used in the design and planning of buildings (e.g. the **product material footprint**[30]). They may also be used by corporations to monitor, report and steer their business model development. Remote sensing can support **real-time monitoring** of forests for both early warnings on disturbances (insects, fire) and in certification schemes as well as to combat illegal logging. Modelling scenarios, in particular on sustainable production capacities (in Germany, the EU and globally) as well as on potential consumption patterns, provide a direction for developing policy measures and evidence for where investment, today, is needed.

4. Support measures to prioritize healthy forests

Resilient and robust forest ecosystems absorb carbon, provide habitats and ensure a stable supply of wood for the bioeconomy. Measures like **payments for ecological services**[8] and continued promotion of a structural shift in the balance of tree species – toward more deciduous species, accompanied by R & D support to also shift industrial applications – are available and needed, in particular to adapt German forests to climate change[31].

5. Promote cascades and long-lived products

One of the best ways to ensure a stable supply of wood is to **use wood more efficiently** and effectively. Incentivizing markets for durable, re-useable and long-lived wood-based products is a key strategy, along with making one-use, throw-away products less attractive options (e.g. double packaging, with multiple measures available[32]). The wood-based panels and pulp sectors combined already source **more than half** of their inputs from recycled wood fibres and residues (54% in Germany in 2015, up from 50% in 2000)[28]. This indicates that recycling is well established in those sectors and that there is a need for a realistic evaluation of potentials. Expansion to new bioeconomy sectors and build-up of business models and infrastructures for re-use requires massive investments in research and development, including technical, **cross-cutting**, and social innovation.

6. Reject direct burning of wood in power plants

It has been found that using primary woody biomass from forests for energy and in short-life wood products "usually leads to **little or no reduction** in GHG emissions compared to the fossil fuel benchmark"[33]. The climate protection effect is higher if trees that are mainly used for such purposes are not harvested[34]. Exceptions exist (e.g. salvage logging, forest restructuring, wildfire prevention), highlighting that carbon accounting requires a **systems approach**[36] and transparency about aims, parameters and scale. The conversion of coal-fired power plants to biomass feedstocks is **not an advisable goal** for policy[36]. Wood can be used for energy – when it cannot otherwise be used (e.g. at the end of a cascade) and then in a local and efficient facility[33]. Over **1 million households** in Germany use wood as their primary energy source for heat[37]. Addressing concerns related to health (e.g. particle emissions) and the environment (e.g. trade-offs with leaving trees to grow or to become deadwood in the forest) are key to ensuring energy safety, security and sustainability. Guidelines to this end have been developed[38].

7. Get the conditions for social engagement right

Lead by example **(green public procurement)** and make it possible for people to engage, conveniently, in repair, re-use and recycling. Invest in and undertake the **structural changes** that make social engagement possible in e.g. urban/rural planning (proximity, mobility, access to recycling centres). Tap into existing social movements (e.g. minimalist lifestyles, tiny house movement, Fridays for Future) to understand their drivers, barriers and potentials for growth. Raise awareness about the **social norms** we live by (e.g. throw-away culture, fast fashion, bigger is better) to find balance in our use of wood.

Altogether, to achieve the value-added vision of the circular bioeconomy – combining **high and low tech innovation, local job creation and balanced consumption** – measures to incentivize long-term uses and re-uses of wood and to eliminate wasteful practices are needed.

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