How to introduce a Circular Economy into the wood supply chain?

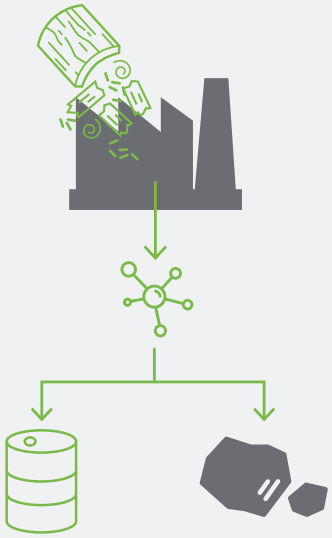
GEOGRAPHICAL FOCUS:

Baden-Württemberg, Germany

THEMATIC FOCUS A:

Recycling wood-based residues through biorefineries

1. Facts on the Potential



What is a biorefinery?

A **biorefinery** is an integrative, multifunctional plant that uses biomass as a diverse raw material source for the sustainable production of a range of different intermediate and final products (chemicals, materials, bioenergy incl. biofuels), using all raw material components as fully as possible. To this end, different processes and technologies are integrated into an overall concept adapted to the respective location[1].

In Baden-Württemberg, biorefineries offer to keep carbon in the cycle as long as possible without releasing CO_2, and strengthen wood-based value chains close to primary producers. Currently, the Bioliq® research project[2] is developing a way to de-centralise the pre-treatment of biomass to obtain an energy carrier of high energetic density. This in turn can be processed centrally in one large processing plant into **bio-based synthetic fuels**. Another already existing application-oriented example from Baden-Württemberg is the case of Carbonauten[3]. This company has developed a process to produce **carbon** through pyrolysis of residues from wood processing, forestry, landscaping and agriculture. Its plants offer mobile and de-centralised easily scalable value-creation opportunities.

1 https://www.bmbf.de/upload_filestore/pub/Roadmap_Biorefineries_eng.pdf
2 https://www.bioliq.de/english/index.php
3 https://www.carbonauten.com/the-carbonauten-system

2. Drivers and Barriers

2.1 Drivers

Category	WHAT BENEFITS WOULD THERE BE IN RECYCLING WOOD RESIDUES IN BIOREFINERIES?
Environmental	• If wood/woody residues are processed into base chemicals in biorefineries, its carbon content will be kept for longer inside the material, meaning that wood and woody plants will continue to perform as CO2 sinks.
Economic	• Biobased chemicals could add value for local wood-based economies, such as in the Adelegg region. It would prolong the wood-based value chain. Moreover, biorefineries could be coupled to already existing facilities, such as decentralised biogas plants, thus reducing the initial purchasing costs.
Social	• With the advent of biorefineries on a small scale and a decentralised level, further competencies for the construction and maintenance of these plants would be needed, thus creating job opportunities in rural areas.
Institutional	• State Strategy "Sustainable Bioeconomy Baden-Württemberg" [4] explicitly recommends the set-up of biorefineries.
Technological & Informational	• Different processes and technologies are integrated into an overall concept adapted to the respective location. • Under the renewable energy act of 2000 [5], plants producing renewable energy, such as biogas plants, have been supported with a special subsidy for twenty years. Following the renewable energy act, a lot of plants were built. As the twenty-year period of support for these initial plants is soon ending, ideas are being explored to ensure future economic viability of these plants beyond the initial subsidy. One of these idea could be to add further biorefinery elements to these plants to diversify revenues and create further value added for biomass.
Supply Chain	• The supply chain of local wood-based economic sectors would be prolonged. More steps in the supply chain would lead to more local value added.
Organisational	• Biorefineries coupled to local biogas plants or biomass-based district-heating plants could benefit from already established logistic networks. In this scenario, no extra organisational (and financial) effort would be needed to proliferate wood/woody residuals to locally available, decentralised biorefineries

2.2 Barriers

Category	WHY IS THE USE OF WOOD RESIDUES IN BIOREFINERIES ONLY PARTIALLY EXPLOITED AT THIS POINT?
Economic	• So far the market for bio-based fine chemicals remains small. Few producers exist. Recently erected wood/woody-based district heating plants need to operate for a number of years until they break even. Until then, wood that could be used in biorefineries competes with wood-based district heating plants.
Social	• Traditional/established structures of wood-based value chains are transmitted throughout wood-based educational programmes, both vocational and academic. This is the impression generated from several site visits during the CirculAlps project and is also a result of discussions with wood-based economy experts. Only the use of wood residues solely in the production of energy is highlighted.
Institutional	• To achieve neutrality of CO2 emissions, public support schemes exist to favour energy from renewable resources. For example, local energy agencies, such as energy agency of the district of Ravensburg[6], foster public-private cooperation to achieve measures ranging from energy efficiency to reducing CO2 emissions. Consequently, the energetic use of wood and woody biomass is favoured and has created an according environment that hinders the flow of wood and woody residues to biorefineries.

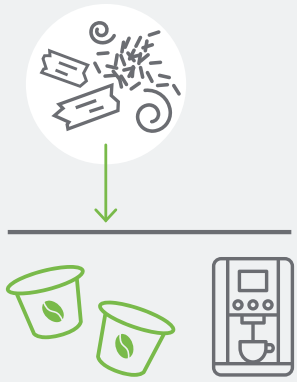
4 https://stm.baden-wuerttemberg.de/fileadmin/redaktion/m-mlr/intern/dateien/PDFs/Bio%C3%B6konomie/Landesstrategie_Nachhaltige_Bio%C3%B6konomie.pdf
5 https://www.erneuerbare-energien.de/EE/Redaktion/DE/Dossier/eeg.html?cms_docId=73930
6 https://www.energieagentur-ravensburg.de/

Technological & Informational	• Little knowledge “out in the field” is available on the possibilities of biorefineries and their potential to complement existing plants, and at this point only few biorefineries even exist at all. In Baden-Württemberg, the processing of wood residues in biorefineries is still in the development phase. Only one company exists that offers mobile plants to process wood residues into carbon.
Supply Chain	• In sawmills, residues are managed either internally through reintroduction into the sawmill’s operations, or they can be collected by a wholesale trader of sawmill residues who then sells these to other processors, for example, chipboard producers. These established streams of sawmill residues provide a barrier to the use of these resources in biorefineries.
Organisational	• All operations in the timber value-chain are streamlined according to current practices. A surrounding value network has developed accordingly. It will be difficult to overcome path dependencies and lock-in streams that favour the energetic use of wood-based residues. As long as the use wood-based residues in biorefineries is not seen on par with the energetic use of this resource itself, the organisation of the wood-based value chains will remain a barrier.

THEMATIC FOCUS B:

Wood-based Residues for wood-plastic Composites

1. Facts on the Potential



In the framework of CirculAlps project, the employees of two large sawmills with a combined turnover of 175,000 m3 of timber were interviewed and distributed questionnaires in which they gave information about their operations. The two sawmills had a process efficiency of 66% and 70%, respectively. In turn, 34% and 30% of total timber worked were classified as residues. Of the two sawmills, one used all of its residues for internal operations, such as the generation of thermal and electric energy or the production of fibre-based insulation boards. The other sawmill only used 10% of its residues internally and sold the rest to wholesale traders of sawmill residues. In the following section, the potential to use wood-based residues from sawmills in **wood-plastic composites** is assessed.
Several companies already exist that make use of wood residues in a multitude of applications, such as **coffee capsules from woody residues**.

2. Drivers and Barriers

2.1 Drivers

Category	WHAT BENEFITS WOULD THERE BE PRODUCING WOOD-PLASTIC COMPOSITES FROM WOOD-BASED RESIDUES?
Environmental	• Zero Waste Approach • Potential of creating wood-plastic composites from wood residues, recycled plastics or bioplastics.
Economic	• Higher value for wood-plastic composites • Less storage costs for huge amounts of residues.
Social	• Identification with regional sustainable value creation and sustainable product.
Institutional	• Engaging Sustainable Development Goals • Engaging “Circular Economy Law” (Kreislaufwirtschaftsgesetz – KrWG [7])
Technological & Informational	• New technologies needed in the area, new employment opportunities • Combination with already existing infrastructure (wood from residues, fibres from biogas residues, plastic from recycling of regional waste management companies)
Supply Chain	• New opportunities • Connecting existing supply chains
Organisational	• New technologies needed in the area, new employment opportunities • Green branding of the region due to a mutual effort and locally sourced materials

2.2 Barriers

Category	WHY IS THE PRODUCTION OF WOOD-PLASTIC COMPOSITES FROM WOOD-BASED RESIDUES NOT FULLY EXPLOITED YET?
Economic	• Potential competition for wood based residues.
Social	• Lack of knowledge of (business) opportunities.

7 http://gaa.baden-wuerttemberg.de/servlet/is/16033/1_2_1.pdf

Institutional	• To achieve neutrality of CO2 emissions, public support schemes exist that favour energy from renewable resources. For example, local energy agencies, such as the energy agency of the district of Ravensburg [8], foster public-private cooperation to achieve measures ranging from energy efficiency to reducing CO2 emissions. Therefore, the energy use of wood and woody biomass is favoured and has created an environment that hinders the flow of wood and woody residues to WPC.
Technological & Informational	• Missing knowledge on how to best produce WPC solely from recycled and/or bio-based sources for multiple applications.
Supply Chain	• In sawmills, residues are managed either internally when they are re-introduced into the sawmill's operations, or can be collected by a wholesale trader of sawmill residues who then sells these to other processors, for example, chipboard producers. These established streams of sawmill residues provide a barrier to the use of these resources in WPC.
Organisational	• No coordinated effort for improving the development of innovative products.

3. Tips for the future

Which administrative & political measures could change the trend and support the use of wood residues in biorefineries and wood-plastic composites?

- Establish local trading platform in which primary producers of biomass, sawmill operators and all other actors that produce biomass can participate. Establish a joint or communal platform on which residues/resources can be collected and then subsequently processed.
- Commit participants to maintain wood biomass resources in the material cycle for as long as possible and only use them for energy production as a final option. This could be potentially done by introducing expected numbers of loops of material use wood residues have to undergo. Another idea would be to introduce a tax on CO2 emissions, thus incentivising maximal material use of wood residues before burning it to produce energy.
- Subsidies innovation. Develop public procurements and calls for local sustainable and innovative products.
- Finally, the subsidisation of biogas plants under the German renewable energy act is limited to twenty years, for many plants built at the beginning of the 2000s, this period is coming to an end soon[9]. To incentivise the coupling of existing biogas plants with biorefinery elements, a new subsidy could be directed to biogas plant operators who are willing to add biorefinery elements to their site.

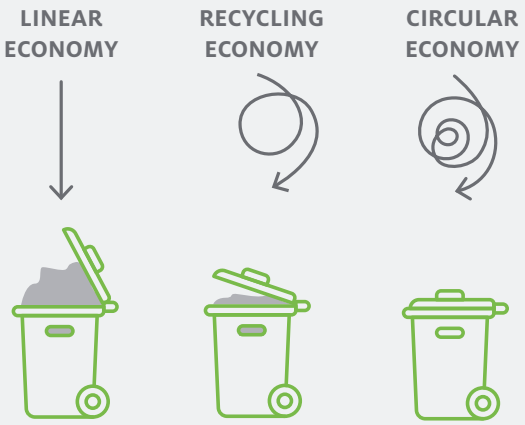
8 https://www.energieagentur-ravensburg.de/
9 https://www.erneuerbare-energien.de/EE/Redaktion/DE/Dossier/eeg.html?cms_docId=73930

The background: CirculAlps project

CirculAlps is a project co-funded by the European Union through the Alpine Region Preparatory Action Fund, within the framework of the European Union Strategy for the Alpine Region. CirculAlps aims at promoting a circular and bioeconomy throughout the Alpine timber-based value chain. CirculAlps project investigates the material flows and value chains of forestry and wood-based sectors of five remote Alpine areas in four Alpine countries: Austria, Germany, Italy and Slovenia. The five research areas differ in their size, but all have in common that their local economy is characterised by forestry and wood-based value networks. The project focuses on the residues of the current wood production chain given their potential for circular economy application.

What is a Circular Economy?

"A CE is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times"[10]. Circular Economy mainly emerges from literature through the 3R principles: **Reduce, Reuse, Recycle**.
Reducing = utilising less input in the production.
Reusing = use again products and components for the same purpose for which they were conceived.
Recycling = any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes[11].



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10 Ellen MacArthur Fundation 2012, Näyhä, 2019: 1297
11 (Ghisellini et al., 2016: 15)