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

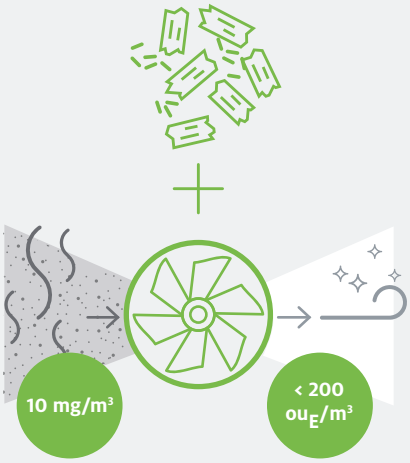
GEOGRAPHICAL FOCUS:

Slovenia

THEMATIC FOCUS A:

Biofilters from woodchips (Upcycling)

1. Facts



What is a biofilter?

Biofilters act to remove unwanted particles, odours or other pollutants, especially in the cleaning of amorphous compounds. Biofilters are composed of a biological reactor, ventilators, a control box, a tank containing softened and heated water, and a spray pump system.

Building a biofilter:

- Selection of woodchips from wood biomass (woodchips of different thicknesses).
- Treatment of woodchips with a biological enzyme and bacterial additives.
- Design of biofilters by selecting proper woodchip size & tree species mixture, which can best perform in that specific waste filtration system.

Examples:

- **Performance of a biofilter:** Previous airborne pollution: 10 mg/m³ of contaminants at 10 to 30 °C
- **Purity level after biofilter:** < 200 odour unit per cubic metre (ou$_E$/m³) (sense of smell)[1]
- **Best practice in Slovenia:** Kostanj d.o.o.

1 Source: Kostanj d.o.o.

2. Drivers and Barriers

2.1 Drivers

Category	HOW WOULD BIOFILTERS BENEFIT THIS CASE STUDY AREA?
Environmental	• High availability of materials. Slovenia is one of the most forested countries in the world. With almost 60% of its surface area covered with forests, it ranks fourth in Europe. • Wood is a potentially highly-efficient material in terms of circular economy. Wood is one of the most "circular" of materials, and the comprehensive management of forest value chains opens up many opportunities for innovation in its use. Nevertheless, there must be special focus on its potentially negative environmental impacts.
Economic	• Existence of opportunities for innovation in the field of materials; the **Strategic Research and Innovation Partnership's** (SRIP) "Smart Buildings and Homes including the Wood Chain" was designed. • Potential for differentiating production and strengthening company brands.
Social	• Increased internationalisation and worldwide awareness of sustainability needs. Potential to increase workplaces and vitality.
Institutional	• Promising instruments in Slovenia. Governmental support via ROADMAP TOWARDS THE CIRCULAR ECONOMY IN SLOVENIA (RTCES) - Circular Economy is one of Slovenia's strategic development priorities. It is closely tied to the Sustainable Development Goals (SDGs) and is included in key national documents such as **A Vision for Slovenia in 2050** and **Slovenian Development Strategy 2030** (Agenda 2030), as well as in **Slovenia's Smart Specialisation Strategy**. • Cross-sectoral integration and interplay between the bio-economy and the circular economy offers new perspectives on the value of forest systems.
Technological & Informational	• Potential for improving existing operations, e.g., new technologies, increased information sharing via specialised platforms like SRIP, RTCES, etc.
Supply Chain	• Potential to increase the added value and reduce the focus on wood as an export material only, through a multidisciplinary approach.
Organisational	• Increased understanding of demand of sustainability. • Circularity integrated in company strategy and goals.

2.2 Barriers

Category	WHY IS THE USE OF WOODCHIPS TO PRODUCING BIOFILTERS ONLY PARTIALLY EXPLOITED AT THE MOMENT?
Economic	• Lack of methods to measure (long-term) benefits of Circular Economy projects.
Social	• Lack of social awareness and uncertainty of consumer responsiveness and demand.
Institutional	• Lack of clear incentives. • Circular Agroforestry Policy does not exist yet. The Slovenian Ministry of Agriculture, Forestry and Food should develop clear guidelines and conditions for the development of agriculture in the direction of circular models, taking into account the opportunities brought about by bio-economics and promoting innovative approaches both in food production and in management of forest value chains.
Technological & Informational	• Lack of market mechanisms for materials recovery. • Except a few examples, there is a lack of information & knowledge, as well a lack of technologies and technical skills.
Supply Chain	• Lack of collaboration. • Small national market. • Lack of network support and partners.
Organisational	• Top down approach (government to SMEs) in the assistance and encouragement of circular economy R&D projects. Communication could be more efficient. General lack of circular economy knowledge and skills.

3. Tips for the future

Administrative & political measures to change trend:

- Organise a platform to make it easier to buy from small farmers or old wood. Promote innovations on national and international platforms.
- Monitor emissions from installed biofilters at the process units, e.g., waste management plants and waste landfills and quality control of air filters for the removal of unwanted particles (odours or other pollutants).
- Initiative for green procurement. Subsidise innovation linked to increased cascading use of wood.

THEMATIC FOCUS B:

Fungal Production on Stumps

1. Facts on the Potential

A considerable amount of wood (**up to 3% of total wood biomass**) remains after harvesting, mainly as stumps or residues of logs left in forest ecosystems for biodiversity and other non-timber forest functions, as required by the national Forestry Act. There is no further instructions how these remains should be treated (if at all). Thus, an option for their directed decomposition is available.

Colonisation of wood residues with specific local strains of wood-decomposing fungi represents a potential for products, either as **edible sporocarps** or as sources of secondary **products required by pharmaceutical, medicinal, or cosmetics industry**.

Best practice example in Slovenia: MycoMedica d.o.o.

What they do: According to MycoMedica d.o.o., the easiest method of cultivating mushrooms is on fresh wood. This method does not require substrate sterilisation, which is necessary when using other cultivation methods. Logs and stumps of freshly cut trees are suitable for cultivation, provided that they are not decayed or rotten. For mushroom cultivation, hardwood from deciduous trees, such as oak for shiitake, beech, hornbeam, maple and alder tree, is most suitable. On the other hand, softer wood species decompose faster and give smaller yields. Wood from coniferous trees has a specific composition, which makes it suitable only for the cultivation of certain mushroom species.

How they do it: for mushroom cultivation on tree stumps, their entire surface is drilled in a zigzag pattern and plug spawn inserted in the holes. Alternatively, a stump can be cut transversely, the top surface spread with grain spawn and covered with a remaining cut-off wooden disc. The prepared stump has to be covered with a plastic film and soil or leaves to protect it from drying up, direct sunlight and animals that feed on spawn. Mycelium usually needs a couple of months to colonise the substrate while the production of sporocarps depends on the season and biology of species seeded. This “directed” decomposition of stumps and other wood remaining is still a fairly unexploited option in regular forestry practices.

2. Drivers and Barriers

2.1 Drivers

Category	WHAT BENEFITS WOULD THERE BE IN EXPANDING THE FUNGAL PRODUCTION ON STUMPS?
Environmental	• High availability of materials and compatibility with the current forest management system. The forest management system with selective thinning of stands forms a suitable conditions for potential cultivation of fungi, which does not imply negative overall environmental impacts.
Economic	• Potential for development, innovation and synergistic opportunities for new businesses. • Potential to increase the use of fungal secondary metabolites in pharmaceutical, medicinal uses, or cosmetics.
Institutional	• Existence of public support schemes. EU structural & investment funds, Ministry of Economic Development and Technology - **CoPro Project** - The first standardised dietary supplement from medical devices Cordyceps.
Technological & Informational	• New technologies, biotechnology, new research opportunities (*e.g. production of antitumor fungal polysaccharides of Ganoderma lucidum and Grifola frondosa by solid state cultivation of wood industry waste, Berovic et al., 2014*).
Supply Chain	• Filling highly specialised niche products demand. • Increasing the added value and reducing the focus on wood as an export material only.

2.2 Barriers

Category	WHY IS FUNGAL PRODUCTION NOT FULLY EXPLOITED YET?
Environmental	• Invasive colonisation materials
Economic	• Lack of methods to measure the long-term benefits of CIRCULAR ECONOMY projects.
Institutional	• Lack of governmental support • Lack of circular economy know how of political decision makers
Technological & Informational	• Lack of knowledge, technologies and technical skills on the field.
Supply Chain	• Lack of collaboration, small national market, lack of network support and partners
Organisational	• Top down approach (government to SMEs) - assistance and encouragement of circular economy R&D projects. Communication could be more efficient, potential reserves in promotional activities of circular economy R&D projects. Lack of circular economy knowledge and skills.

3. Tips for the future

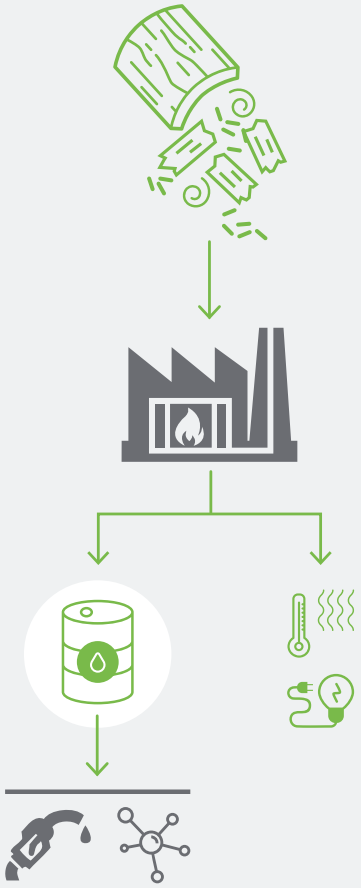
Administrative & political measures to change trend.

- Offer instruments for individual producers of mycelia to easily connect with farmers/forest owners and end users of mushrooms / secondary products. Promote knowledge support at all levels to support the good design of products (design from cradle to grave).
- Increase of visibility of fungi / mushrooms as a potential resource and source for specialised industry and tourism.

THEMATIC FOCUS C:

Use of biochar from wood gasification power plants

1. Facts on the Potential



What is biochar?

Pyrolysis of biomass at higher temperatures produces recalcitrant charcoal called biochar, as well as volatile gases, a portion of which may be condensed into liquid pyrolysis oil, also called bio-oil. Biochar can be used in its raw form as a **solid fuel** or used as a feedstock for the production of other products, including **chemicals**, and **soil additives**. The use of biochar as a soil amendment is the subject of intensifying scientific inquiry. Biochar have received the most attention for their ability increase carbon sequestration while reducing atmospheric carbon dioxide concentrations. Biochar has many other uses that can be integrated into new organic systems for farming, building, clothing, electronics and a whole range of consumer products.

How is it produced?

Sawmills and other wood processing industries produce large quantities of woody biomass in the form of wood chips, sawdust, shavings and bark. These are either sold as raw material for pulp and paper industries, wood panels production, wood pellet production, landscaping applications, or used as fuel for energy production. The forest sector also produces woody biomass as a by-product of silvicultural treatments. These forest residues include foliage, tops, limbs, unmerchantable roundwood, and stumps. Some of the latter are burnt in the forest to reduce the risk of wildfires and clear growing space for regeneration, the rest is used for energy production. The thermochemical biomass conversion has the potential to produce heat, power, fuels and other products from forest biomass. In a wood gas power plant, wood chips are first converted into a gaseous fuel that powers an a gas engine that produces electricity and heat by means of thermochemical processes. During this process, the formation of **biochar as a co-product of the gasification process is intentionally restricted** to maximise the energy recovery.

The current situation in Slovenia:

There are currently 42 registered producers of electricity with total installed capacity 22 MWe. More than 10 % of installed capacity involves wood gasification processes. Potential use of biochar as described above gives a new opportunity to this energy producing companies.

2. Drivers and Barriers

2.1 Drivers

Category	WHAT BENEFITS WOULD THERE BE PRODUCING AND UTILISING BIOCHAR?
Environmental	• Biochar is a by-product of electricity production and could be used in many environmental friendly applications. • Biofuels and bioproducts may also offset fossil fuel use and associated emissions with renewable forest resources.
Economic	• The utilisation of biochar would make the whole production of heat and power more profitable. With new income, new jobs could be created.
Social	• New jobs creation in a remote community where opportunities are otherwise limited. With new jobs provide also additional income in local community and indirect and induced impacts on local development
Institutional	• Available governmental support in Slovenia ROADMAP TOWARDS THE CIRCULAR ECONOMY IN SLOVENIA (RTCES). The latter is closely tied to the Sustainable Development Goals (SDG's) and included in key national documents such as **A Vision for Slovenia in 2050** and **Slovenian Development Strategy 2030** (Agenda 2030) as well as in **Slovenia's Smart Specialisation Strategy**.
Technological & Informational	• New technologies for further processing of biochar could be developed, new research opportunities and opportunities for international cooperation.
Supply Chain	• Further use of by-products like biochar gives new value to wood energy supply chains. It also gives a new option for further development of all parts of supply chains that are very important for Alpine space and for selected regions. Increasing the added value of low-quality wood and wood residues and multidisciplinary approaches are important elements in the further development of wood-energy supply chains.

2.2 Barriers

Category	WHY IS THE PRODUCTION AND USE OF BIOCHAR NOT FULLY EXPLOITED YET?
Economic	• Unknown market for new products.
Institutional	• Lack of governmental support • Lack of circular economy know how of political decision makers
Technological & Informational	• There is a lack of information & knowledge in the region, as well as in Slovenia.
Supply Chain	• Lack of collaboration, small national market.
Organisational	• Propensity to foster the maximisation of energy recovery in the production process, to the detriment of energy recovery.

3. Tips for the future

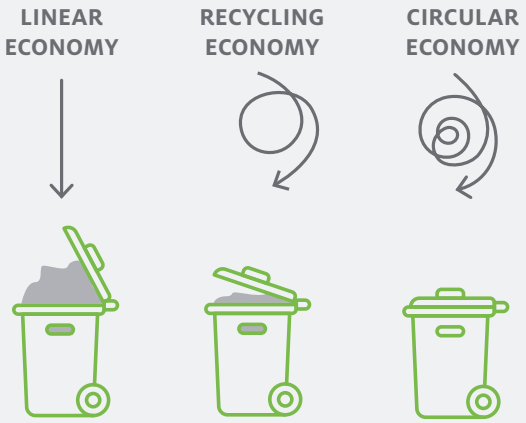
- Increase the visibility of biochar as a potential source for specialised products, especially in agriculture.
- Support knowledge acquisition on the topic by connecting SME and R&D institutions in the region.
- Foster international cooperation and transfer of knowledge.

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"[2]. 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[3].



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