

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

GEOGRAPHICAL FOCUS:

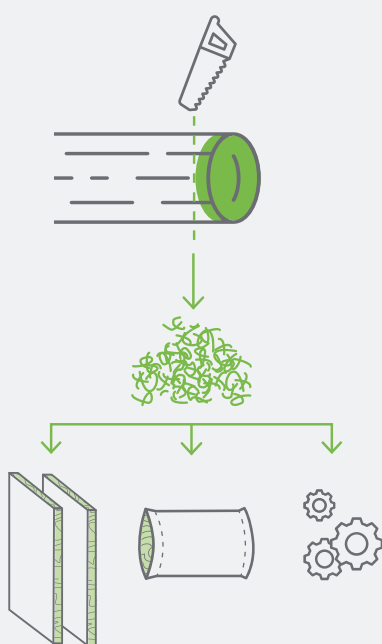
## Trentino

THEMATIC FOCUS A:

## Upcycling shavings to wood wool



### 1. Facts



In Trentino forest owners, forest enterprises and sawmills produce in average 215,725 m<sup>3</sup> of by-product, of which 41% (89,421 m<sup>3</sup>) is sawdust and shavings. Only 9% (20,483 m<sup>3</sup>) of this is reused within the companies for their own sustenance (energy purpose), 91% (195,242 m<sup>3</sup>) is sold to tertiary parties, who use them to produce energy in district heating plants of the regions.

One part of the residues is the **end-trimming of logs**, generated in forestland and sawmills. These are currently mostly used for energy production. However, after debarking they could be an interesting material for the production of **wood wool**.

Wood wool boasts an expanding market due to several possible uses; for example, in **insulation panels** (after mineralisation) or for soil **engineering purposes**<sup>1</sup>. It could also be used for specific **artisan products**, such as for fillings for pillows. Here, the most common species used is Swiss pine, but other species could be tested.

<sup>1</sup> Best practice example: Lintner Holzbau company

## 2. Drivers and Barriers

### 2.1 Drivers

Category	HOW WOULD THE USE OF RESIDUE IN THE PRODUCTION OF WOOD WOOL BENEFIT THE CASE STUDY AREA?
Environmental	<ul style="list-style-type: none"><li>• Use of residues and low-quality wood.</li><li>• Environmentally-friendly material with potential in soil engineering, i.e. for the stabilisation of slopes, and in construction to produce insulation panels for increased energy efficiency of buildings.</li></ul>
Economic	<ul style="list-style-type: none"><li>• Higher added value use compared to currently existing uses for energy production.</li><li>• Reduced costs for disposing edge logs.</li><li>• New job opportunities with the introduction of new products.</li></ul>
Institutional	<ul style="list-style-type: none"><li>• Increased energy efficiency of public buildings where the wood wool is used.</li></ul>
Technological & Informational	<ul style="list-style-type: none"><li>• Trigger for wood processing machines producers to develop new machines or to improve old ones (i.e., without the need for predefined dimensions of the woody supply input).</li></ul>
Supply Chain	<ul style="list-style-type: none"><li>• Introduction of the “cascading” approach in the value chain.</li></ul>

### 2.2 Barriers

Category	WHY IS THE PRODUCTION OF WOOD WOOL ONLY PARTIALLY EXPLOITED UNTIL NOW?
Economic	<ul style="list-style-type: none"><li>• The current energy chain is well assessed and rapid. The wood wool production chain is new and needs to be developed and optimised. This might reduce profits in the initial phase.</li><li>• Economic feasibility: the few producers of wood wool in Italy should be using the raw materials within 200 km. Longer distances could have negative consequences on the convenience of the production. This aspect should be investigated more thoroughly.</li></ul>
Technological & Informational	<ul style="list-style-type: none"><li>• Low awareness of potential of this resource. Applications are currently limited to a few companies that use wood wool to produce homemade panels.</li></ul>
Supply Chain	<ul style="list-style-type: none"><li>• Industries in Italy produce wood wool for their own applications, not for resale.</li></ul>
Organisational	<ul style="list-style-type: none"><li>• The current organisation of the value chain supports the use of residues for energy production, even when this implies long-distance transportation of the material.</li></ul>

## 3. Tips for the Future

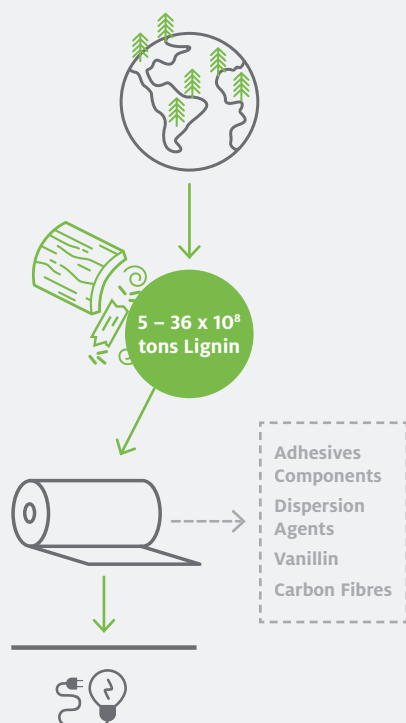
### Administrative & political measures to change trends:

- Incentivise the production of machines to work wood wool from low quality material.
- Develop studies, possibly followed by regulations that encourage the use of wood residues within 200 km from the processing plant. Life Cycle Assessment is a valuable tool to examine pros and cons.

## THEMATIC FOCUS B:

# Lignin Based Products from recycled Wood Waste

## 1. Facts on the Potential



### What is lignin?

Lignin is one of the **main constituents of terrestrial plant biomass**. The annual amount formed in nature has been estimated in the range from 5 to  $36 \times 10^8$  tons. Lignin sources are mostly trees (wood, bark) with softwoods boasting a higher content of lignin than hardwoods. Lignin is also contained in other resources such as straw from grass. Its chemical structure varies with plant species and geographical provenance.

### Lignin extraction and processing:

Lignin isolation happens through different processes (kraft, sulphite, organosolv, etc.), which can affect its final chemical structure. Furthermore, after extraction, lignin depolymerisation is necessary to produce monomeric lignin fragments that can serve for the synthesis of new high value products using chemical or biological catalysis. Some lignin products are currently entering the market. The most abundant source of lignin, estimated to be 130 million tons each year, is produced as a low-price by-product by the paper industry. Currently, the lignin side-stream in paper industry is mainly used for on-site energy generation despite the existence of several other lignin applications in niche markets. For example, **adhesives components; dispersion agents; source for high-value compound vanillin, carbon fibres.**

Three main groups of stakeholders play a relevant role in the lignin sector: 1) lignin producers; 2) companies with know-how for lignin depolymerization processes for building blocks production; 3) companies that use building blocks to prepare the final biochemical products (agrochemicals, products based on carbon fibres or chemicals deriving from lignin).

## 2. Drivers and Barriers

### 2.1 Drivers

Category	WHAT BENEFITS WOULD THERE BE IN EXPANDING THE LIGNIN PRODUCTION AND USE?
Environmental	<ul style="list-style-type: none"><li>• Lignin is a renewable resource and it is very abundant in nature.</li><li>• The product can replace synthetic vanillin, as vanillin production from lignin is a bio-based process.</li><li>• Lignin by-products from paper industry are re-used instead of being burnt. The sequestered carbon also gets stored over longer time.</li><li>• Lignin represents a renewable resource to produce carbon fibres.</li></ul>
Economic	<ul style="list-style-type: none"><li>• Favourable market conditions: high demand for vanillin in the already well established food flavours market; lignin represents a cheap starting material for vanillin production.</li><li>• Carbon fibres produced from lignin represent another interesting market that is currently growing.</li><li>• Lignin-based dispersants with low-cost production.</li></ul>
Social	<ul style="list-style-type: none"><li>• The use of lignin for the selected products can create new jobs.</li></ul>
Institutional	<ul style="list-style-type: none"><li>• Consistent with: The 2015 EU Circular Economy Strategy and Action Plan and the 2012 EU Bioeconomy Strategy and Action Plan.</li></ul>

<b>Technological &amp; Informational</b>	<ul style="list-style-type: none"> <li>• Potential for improving the protocols to isolate and depolymerize lignin from new feedstocks like forest and agricultural residues e.g. using biotechnological methods.</li> <li>• Biotechnological methods reduce the use of chemicals and energy requested to obtain lignin, which must be further explored.</li> </ul>
<b>Supply Chain</b>	<ul style="list-style-type: none"> <li>• Vanillin from lignin and lignin-based dispersant production currently exists but is underdeveloped</li> </ul>

## 2.2 Barriers

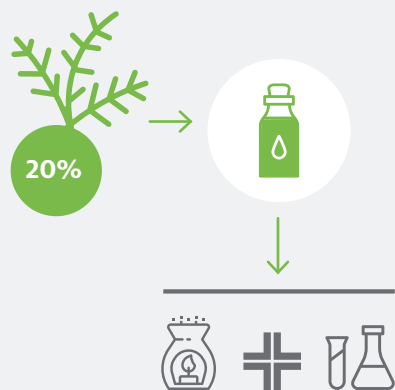
<b>Category</b>	<b>WHY ISN'T LIGNIN PRODUCTION FROM WOOD RESIDUES FULLY EXPLOITED YET?</b>
<b>Environmental</b>	<ul style="list-style-type: none"> <li>• Isolation of lignin and depolymerisation is energy consuming, also requiring a high consumption of chemicals.</li> </ul>
<b>Economic</b>	<ul style="list-style-type: none"> <li>• The paper industry is the main industry able to provide a feasible source of lignin at a relatively cheap cost.</li> </ul>
<b>Technological &amp; Informational</b>	<ul style="list-style-type: none"> <li>• Some processes in lignin isolation (outside the paper industry) and depolymerisation are still in the research and development phase. Technology improvement is still required to isolate lignin from alternative feedstocks such as agricultural wastes.</li> <li>• Lignin-based products are used in Italy, but the value chain is not well known.</li> <li>• Lignin composition and quality is highly variable.</li> </ul>
<b>Organisational</b>	<ul style="list-style-type: none"> <li>• The companies of the possible chains are not in contact with each other.</li> </ul>

## 3. Tips for the future

### Administrative & political measures to change trend.

- Some Alpine regions have lower potential since they are less industrially developed in the chemical and biotechnological sectors. Therefore, informing and making them aware about these new value chains and the innovative opportunities of lignin would be relevant. Furthermore, boosting the contacts among different stakeholders (see also project AlplinkBioEco<sup>2</sup> activities) could help. Additionally, further investigating the chemical composition, toxicity of the final products, as well as their strength and weakness points, is beneficial.
- Finally, incentivising the project for vanillin production from lignin, creating research projects to isolate lignin with a cheap and eco-friendly process, as well as looking at transportation from paper industry and biotechnological companies to develop more eco-friendly processes to obtain and depolymerise lignin, could support the spreading of this production.

## 1. Facts on the Potential



The forested area in Trentino is 390,463 ha (63% of the whole territory). The most popular species in harvesting is the spruce (31.8% of all area), so the major round-wood production comes from it and it is more than 300.000 m<sup>3</sup> (in 2016, the last official data was about 334,000 m<sup>3</sup>). It is estimated that at least the 20% of it is formed by the residues of forest harvesting operation (treetops and branches). Notarangelo et al. (2008) shows that in Trentino each year 62,200 m<sup>3</sup> of residues are left in forest after harvesting, which corresponds to 18,300 tons of biomass. To exploit as much forest residues as possible, the logistics and methods of forest harvesting is quite important. This biomass could be entirely collected if tree full system is used, since extraction of harvested wood from the forest by cable yarders is quite efficient. From **needles and small branches**, **essential oils** can be extracted and further used for **cosmetic** or **pharmaceutical applications**.

## 2. Drivers and Barriers

### 2.1 Drivers

Category	WHAT BENEFITS WOULD THERE BE IN PRODUCING ESSENTIAL OILS FROM NEEDS AND SMALL BRANCHES?
<b>Environmental</b>	<ul style="list-style-type: none"> <li>Reduced time of wood landing on site, so reduced risk of pathogen attack.</li> </ul>
<b>Economic</b>	<ul style="list-style-type: none"> <li>Raw material has low or negligible costs.</li> <li>Final product has high added value. On average, obtaining 1 litre of oil requires 500-600 kg of the plant (yield of spruce: 0.2%); the finished product costs 700 €/l<sup>3</sup>.</li> <li>The demand is increasing, but there is no official data regarding essential oil use, because it is used in many sectors (cleaning, pharma, cosmetic, etc).</li> <li>High demand of the final product, especially in wellness tourism (aromatherapy and massage), included in the Smart Specialisation Strategy of Trentino.</li> </ul>
<b>Social</b>	<ul style="list-style-type: none"> <li>Extension of the value chain, therefore creating more jobs, especially specialized ones.</li> </ul>
<b>Institutional</b>	<ul style="list-style-type: none"> <li>Consistent with main strategy: European Union Circular Economy Strategy and Action Plan (2015); European Union Bioeconomy Strategy and Action Plan (2012).</li> <li>Incentives to produce essential oil and officinal plants (Italian law: D. lgs 21 May 2018 n. 75, art. 18).</li> <li>Synergy with other projects, for example, the TRANSALP project: Circular economy to the farmers in rural Alpine Region for sustainable growth<sup>4</sup>.</li> </ul>
<b>Technological &amp; Informational</b>	<ul style="list-style-type: none"> <li>Potential for improving existing operations in the forest-wood-energy chain and new technologies.</li> </ul>
<b>Supply Chain</b>	<ul style="list-style-type: none"> <li>The supply chain already exists, even if it is not commonly known.  <b>Best practice example:</b> the energy plant Fiemme has a good production of energy which is converted into hot steam. This is used in a distiller pilot plant by a local company<sup>5</sup> to obtain essential oils. The energy plant has the advantage to use the produced energy more efficiently and avoid burning green residues, which don't burn well due to their high moisture content.</li> </ul>
<b>Organisational</b>	<ul style="list-style-type: none"> <li>Improved efficiency of the production chain, because the produced surplus-energy as side stream will find a different use, instead of being dissipated in the environmental surroundings.</li> </ul>

<sup>3</sup> Source: Interview with producer

<sup>4</sup> Source: [www.alpine-region.eu/projects/transalp-bringing-circular-economy-farmers-rural-alpine-region-sustainable-growth](http://www.alpine-region.eu/projects/transalp-bringing-circular-economy-farmers-rural-alpine-region-sustainable-growth)

<sup>5</sup> "MAGNIFICA ESSENZA SRL SB" company, located in Val di Fiemme (Trentino) represents a best practice. Website: [www.magnificaessenza.it](http://www.magnificaessenza.it)

## 2.2 Barriers

Category	WHY IS THE PRODUCTION OF OIL FROM NEEDS AND SMALL BRANCHES NOT FULLY EXPLOITED YET?
Environmental	<ul style="list-style-type: none"><li>• A part of green forest residues must be left in the forest to increase biodiversity. It is not recommended to remove all the green biomass.</li></ul>
Technological & Informational	<ul style="list-style-type: none"><li>• The supply chain is possible, and it is in respect of the assumption of cascade use. Nevertheless, it is still not well known, for this reason the companies sell directly their residues to DHP.</li></ul>

## 3. Tips for the future

### Administrative & political measures to change trend

- Increase dissemination of information about the existence of this possible use. Removal of the green residues inside the forest is not mandatory, so suggesting to forest organisations to bolster agreements between the forest companies and the industry which apply for these kind of products might be helpful. Moreover, the forestry office could suggest the adoption of a full tree system methodology of forest harvesting.
- Fulfilling the biodiversity and ecological function is important. The forests need green biomass on the soil for biodiversity and cover protection. A control on the quantity that the forest companies collect during harvesting is necessary.
- Incentivise the project for essential oil distillation, using a cascade use concept.
- Try to boost energy plants to use part of their biomass (green) for high value chain.
- Incentivise different logistics in forest wood chain.

### Sources

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# 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”<sup>6</sup>. 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<sup>7</sup>.

### LINEAR ECONOMY



### RECYCLING ECONOMY



### CIRCULAR ECONOMY



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6 Ellen MacArthur Foundation 2012, Näyhä, 2019: 1297

7 (Ghisellini et al., 2016: 15)