Good practice catalogue

Good practices from the woodworking value chains in reuse, recycling and circular economy approaches

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European Commission

Executive summary

The Good Practice Catalogue presents regional diversity and good performance of the European woodworking industries' value chains. In total, 25 good practice examples and company cases are presented in this catalogue. They were selected on the basis of the performance of the overall system and their potential transferability to other regions profiled by applying a set of 13 indicators. The catalogue has been realized with a strong engagement and involvement of the key stakeholders to give an idea of how widely woodworking industries cover the circular economy concept already. However, there is still potential to grow the European circular bioeconomy by specific support actions to enhance the environmental, economic and societal impact of woodworking industries.

The good practice examples and company cases illustrate the regional framework conditions for the circular transition of the woodworking industries compiled from four European macro-regions: Nordic-Baltic, Central-Western, Southern-Mediterranean and Central-Eastern Europe. Nordic-Baltic macro-region is characterized by multi-actor industrial symbiosis and business model innovations. Central-Eastern macro-region is characterized by a great diversity of forest resources and strong potential for green industrial growth. Central-Western macro-region is characterized by high value-added production which integrates effective reuse and recycling processes. Southern-Mediterranean macro-region identifies with a high degree of public perception and procurement processes boosting innovative recovery networks and post-consumer production.

All good practice examples and company cases are grouped in four thematic areas: Circular Operational Concepts, Efficiency and Processing, Reuse and Recycling and Waste and Side Stream Valorization. Reuse and recycling are in the heart of the circular bioeconomy ensuring the optimal use of resource and adding value to waste and side streams by opening new opportunities along wood value chains. The circular economy concept must be driven by improved value chain collaboration, co-creation, partnerships and platforms as well as practical business and operational concepts. High process and material efficiency are features of well-functioning value chains and are also pathways to well-balanced, effective and cost-competitive use of wood resources and side streams.

With a view to the various good practices, this catalogue provides information on the state of the circular economy in the woodworking industries and how they contribute to the circularity and sustainability goals set by the European and global policies (Green Deal, Fit-for-55, the New Circular Economy Action Plan, the Biodiversity Strategy, the Forest Strategy, the New European Bauhaus Initiative and the United Nation's Sustainable Development Goals 2030). The compilation of good practice examples in this document illustrates very well how woodworking industries pave the way for the circular transition of Europe.

The European woodworking industries in the heart of the Circular Bioeconomy

Wood is the most important natural resource, prevalent in our daily lives and in the circular bioeconomy. Wood is widely used in construction, furniture, textiles, fuels, fine chemicals, pharmaceuticals and many more applications. Contributing to the goals set by the European Green Deal, Fit-for-55, the New Circular Economy Action Plan, the Biodiversity Strategy, the Forest Strategy, the New European Bauhaus Initiative and the United Nation's Sustainable Development Goals 2030, the smart use of wood becomes the driving motor of the European woodworking industries' competitiveness and the well-being of the society.

The construction sector represents one of the biggest sources of waste in terms of volume. 70,5 million tons of wood waste are approximately generated annually, and of which only around one third is currently reused or recycled. Optimised value-added use of wood in the construction value chain by reducing waste and enhancing cascading concepts are at the core of the circular bioeconomy.

The transition towards circularity requires the commitment of all stakeholder groups to understand and to take into consideration the diversity of value chains and regional framework conditions. The compilation of some good examples in this document illustrates very well how woodworking industries today address all above mentioned characteristics and pave the way for the circular transition of Europe.

The Good Practice Catalogue

The Good Practice Catalogue presents regional diversity and good performance of the European woodworking industries' value chains. These examples had been realized with a strong engagement and involvement of the key stakeholders. They give an idea of how widely woodworking industries cover the circular economy concept already. There is still potential to grow the European circular bioeconomy by specific support actions to enhance the environmental, economic and societal impact of woodworking industries.

The WoodCircus Project

WoodCircus main goal is to promote wood-based value chains as a key part of a circular bioeconomy in Europe. This goal is pursued by studying, assessing and highlighting efficiency of wood-based value chains in the woodworking industries and the construction sector. It incorporates the mobilisation and first transformation of wood, building and construction activities, production side streams, reuse and recycling aspects. Contributing to the development of sustainable societies, the transition and support of the woodworking industries will lead to more employment and well-being of the European citizens.

Key goals of WoodCircus include the compilation of existing empirical knowledge and practical know-how on good practices in the woodworking value chains to optimise the use of forest resources and to raise public awareness. Important stakeholder groups were involved at every stage of the project. In addition to the technical aspects, WoodCircus addresses regulatory issues that affect woodworking industries and associated sectors.

Good practices in four European macro-regions

The good practice examples show the regional framework conditions for the circular transition of the woodworking industries compiled from four European macro-regions: Nordic-Baltic, Central-Western, Southern-Mediterranean and Central-Eastern Europe.

Northern-Baltic macro-region

Industrial symbiosis and business model innovation within supportive governmental environment and good access to forest resources

In the Northern-Baltic macro-region, long-lasting experience and a deep knowledge and expertise regarding future-oriented product development exist. Industrial clusters are a good example of multi-actor cooperation between forest industry, public authorities, financers and investors. Well-functioning value chains with closed-loop operations as a result of high-level integrated cooperation is one of the biggest strengths of the macro-region. The positive and predictable regulation development as well as supportive markets and preferential public procurement for timber construction boost the circular economy of the macro-region. Integrating first and secondary transformation processes (construction products and materials, biorefining products, etc.) enable woodworking industries to transform towards more cascading and circular business models.

Central-Eastern macro-region

Strong potential for green industrial growth and business model innovations with a wide diversity of forest resources

In the Central-Eastern macro-region, the woodworking industries gain a more central role in the regional economy supported by incentives from public bodies aligned with the transition towards circularity. The access to a diverse forest resource valorized in various manufacturing processes is one of the biggest strengths. Further development of the circular economy concept, in relation to reuse and recycling as well waste and side stream utilization, shows potential to be realized via multi-actor collaboration and adaptation of standardization processes and business models.

Central-Western macro-region

High value-added production integrating effective reuse and recycling steers innovation

In the Central-Western macro-region, recycling and waste management companies produce a large portfolio of high value-added products. Adapted novel technologies and manufacturing processes turn recycled materials into value-added construction and furniture products. This is one of the biggest strengths of the macro-region, and is supported by the effective policies. The finetuning and harmonization of the legislation and regulation processes are identified as main driver in the transition towards circularity. Consumer awareness is addressed by newly developed responsibility schemes (e.g. take back of disposed furniture or other products).

Southern-Mediterranean macro-region

Public perception and procurement processes boost innovative recovery networks and post-consumer production

In the Southern-Mediterranean macro-region, innovative recovery networks composed by a large number of active stakeholders and well-functioning value chains are the engine of efficient reuse and recycling of wood waste and side streams. A high environmental awareness of consumers and environmental policies enhance the uptake of recycled products in the markets. The region clearly demonstrates that costs of recycling can be reduced when reverse logistic processes such as collection, treatment and remanufacturing are improved. Further innovation potential is identified in new circular operations and business concepts.

13 indicators to describe good practices

13 indicators have been developed to understand the performance of the different good practices presented in this catalogue. Those of the 13 indicators which are relevant for each case were selected to profile the circular performance of the good practice.

The set of indicators can be used to identify potential further developments and improvements in the products and the processes towards circularity.

#1 Share of reused, recycled or co-used wood

Percentage of second hand wooden biomass

This indicator describes the level of reused, recycled and co-used wood in products. It is an essential quantifying element of the reused and recycled material flows in the circle.

#2 Recycling potential

Capacity to reuse and to recycle materials

This indicator describes the potential to which extent a product is reused or recycled at the end of its use or application.

#3 Waste management

Smart use of waste

This indicator describes the efficiency of the waste management along the wood value chain.

#4 Product lifetime

Durability of product

The product lifetime is an indicator for the lifespan/application of a product describing the duration of its first use.

#5 Contaminants of product

Purity of the product

This indicator describes the presence of undesired substances in the product which can hamper the reuse and recycling of the material.

#6 Energy efficiency

Energy use

This indicator describes the energy efficiency of the product.

#7 Sustainability of the wooden biomass

Sustainability labelling

This indicator takes into consideration if the product has been certified according to existing sustainability labels.

#8 Innovation

Novelty

This indicator takes into consideration the degree of innovativeness of a product.

#9 Social acceptance

Consumer perception

This indicator takes into consideration consumer behavior towards products with recycled materials.

#10 Political and regulatory framework

Legislation and regulations

This indicator focusses on political and regulatory frameworks for production and consuming.

#11 Resource Efficiency

Smart use of wood

This indicator describes the optimal use of natural resources for the products.

#12 Climate change

Carbon neutral production

This indicator describes the level of green house gas emissions throughout production and consumption.

#13 Economic viability

Economic feasibility of actions

This indicator takes into consideration the economic feasibility of the actions.

Has the rating system piqued your interest?

Learn more about how you can measure the circularity of wood products with the rating system and scan the QR code.

Reuse and recycling

Reuse and recycling are in the heart of the circular bioeconomy.

Most relevant WoodCircus indicators in this category

Share of reused, recycled or co-used wood

The reuse and recycling ratio shows the amount of secondary sources that are used in the production. Initial product design is essential to ensuring the eventual reuse or recyclability of a product or its components.

Recycling potential

The potential of using recycled wood at a larger commercial scale is growing across Europe enlarging the current portfolio of products as currently the main end-uses for recovered wood are energy generation, wood-based panel manufacture, animal bedding, mulches, equine surfaces, pathways, coverings and many more.

Political and regulatory framework

The legislative frameworks necessary to enhance the reuse and recycling of new and existing wood products are needed to support networks between a variety of partners along the value chain to boost innovative development and market demand.

Innovation

Technical and social innovations are needed to improve the circularity in production, networks and market uptake.

Waste management

Expanding the valorization of side stream-based products advance waste management operations.

Social acceptance

Increasing public acceptance of circular operations and the attractiveness of circular systems and products is considered crucial for the advancement of circular strategies.

Sustainability of wooden biomass

Securing product sustainability by sourcing virgin wood from labelled forest management schemes as well as with optimal use of side and recycling streams.

Upcycling sawmill residues to value-added fibre products

Through smart utilisation of wood side streams and post-consumer wood, material efficiency of wood improves. Technical fibre products for different purposes enhance profitability of wood-based products. Application fields can vary from animal feed, the food industry to filter aids, fillers or functional fibres in biocomposites. Various technological material solutions exist and are ready to be exploited in optimal processing of even the smallest residues. Post-consumer wood is only suitable for technical applications and not for food and feed. For the wood fibre processors, animal feed is a significant and growing market. Wood fibres are also used as extract cellulose mainly as a filter aids for the food industry.

Image: Holzmühle Westerkamp

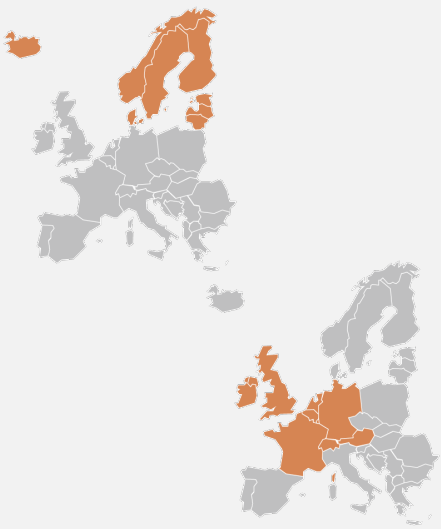
Why is it a good practice?

- 100% recycled wood provides the highest level of recycling of today
- Advanced waste management facilitates postconsumer wood to be used as wood fibres for technical and added value applications
- Wood- and food fibres are a sustainable solution for many sectors
- Technical wood fibres provide functional use for side streams
- The public acceptance for post-consumer wood fibres is enhanced
- The resource efficiency of wood is raised by cascading activities

Regional coverage and transferability

The leading companies selling fibres for a broad range of applications are identified today in Central and Northern Europe but more and more small companies across Europe are also selling fibres for different application and valorisation areas.

The technology is transferable to dominant wood processing countries and regions with a focus to North and Central Europe.

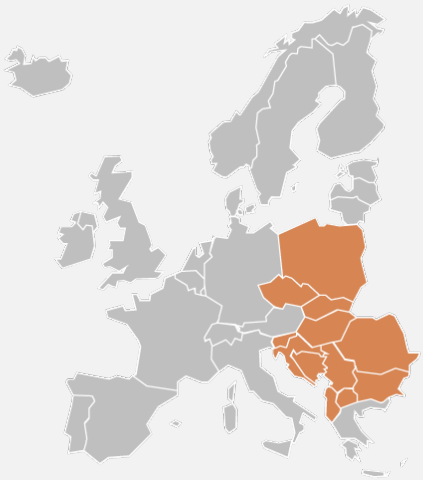


New life for old windows and doors

Recovery of wooden windows and doors is made possible by circular design approaches. In this way, distinctive products combining tradition with high technology keep the original charm of wooden building elements. When these windows and doors are upcycled for reuse, it can be seen as a prime example for long-life products. Wooden windows can be motorised and integrated in smart homes to enhance comfort and usability. Doors can be improved by using advanced joinery. Cases like these are of high importance as carbon in the old products remains to be stored. Furthermore, these cases help raise consumer awareness for the circular use of house elements and even to reduce the negative perceptions that exist about waste materials. Companies have even begun developing apps to improve wood recovery, which allows users to share excess wood materials.

Regional coverage and transferability

At this moment, the good practice of collection of wooden house elements such as doors and windows is presented in Eastern Europe. Regarding transferability differences of cultural building architecture must be acknowledged that can complicate disassembly. However, the practice is highly transferable to many more wood and window manufacturers within Europe and beyond. Digitalised platforms within regions can support local knowledge and awareness on disposal of wood-based materials after use and/or products.



Images: MSORA

Why is it a good practice?

- Recovered wood from characteristic and/or even historical building structures (e.g., barns, mills, sheds, and residential homes) is upcycled into modern, high value products such as new wooden doors or windows.
- Supporting technologies (wood scantling or joineries)
- Modular design approach and embedded smart sensors can prevent decay and prolong product life span.
- Digitalisation concepts and tools like apps for wood sharing are innovative approaches that includes consumer perception and behaviour.

Particleboards from side- and waste streams

More recently, post-consumer wood has been used as raw material for the production of particleboards. The main challenges using post-consumer wood are chemical-treated wood products such as painted or varnished materials. How can these be re-used or removed for new panel production in a profitable way? Large investments into recycling plants are needed in order to implement a recycling system on a national level. Good practice cases present well-established, advanced systems for recycling locally sourced post-consumer wood waste from demolition and municipal waste collection that can be recycled in an efficient way.

Why is it a good practice?

- Particleboards are one of the best examples of full-circle recycling within the wood working sector. Post-consumer particleboard is often recycled into new panels with great efficiency.
- From a technological point of view, almost 85% of the product can be made of recycled side-streams or waste wood. At the European level, the share of recycled wood comprises between 30 and 75% and normally includes side stream wood as well.
- The legal situation of the waste wood disposal is not well regulated at European level making regional legislation very important to waste wood collection and use. Recycling from waste wood takes place predominantly in the wood-based panel industry, this is a good practice and more favorable than energy recovery which is the main end-of-life use for waste wood today.
- Self-initiated collaboration between particleboard manufacturers, local recycling companies, organisations and municipal waste systems presents an improved waste management outcome.
- Greenhouse gas emissions from the production can be reduced significantly.

Regional coverage and transferability

Regarding the recycling of wood panels, South European countries are leading with innovations and investments into recycling plants. Location of recycling plants are depending on well-established or accessible wood collection systems.

Waste collection is predominantly not centralized in many European countries. Therefore, the highly regional and heterogeneous collection systems shall not put limitations to the geographical location. Smart and innovative technologies and systems, even for specific processing is widely transferable.

Upcycling and -scaling in furniture value chains micro-ecosystems for cascading use of wood

More and more innovative designers establish start-ups that produce unique products from post-consumer materials. According to this circular principle furniture and fittings can be produced from locally recovered wood such as sawmill by-products (shavings, sawdust), logs and recycled wood (leftovers, furniture waste) .But for this a collection system for the furniture has to be in place. This is an example of local furniture ecosystem that is made possible through smart collection of old furniture and side streams of production. It starts from the deposit and implies the whole production process a custom-made serial manufacturing of furniture produced. For furniture waste, suppliers are local household waste recycling centres. The value chain is based upon a regional reverse logistics and supply system, tailored to the needs of the specific innovative start ups and architect's!

Regional coverage and transferability

While a good practice of collecting old furniture is found from Central Europe (North of France) it is assumed that more and more of such start-ups will enter the market as the availability of used furniture and furniture parts and acceptance for post-consumer wood products increases. Designers take into consideration on how used wood can be applied and valorised after a variety of further treatments and modifications. From this point of view, the technology of collection and producing furniture is transferable. A regional limitation might rather be related to the level of recycling options within a region.

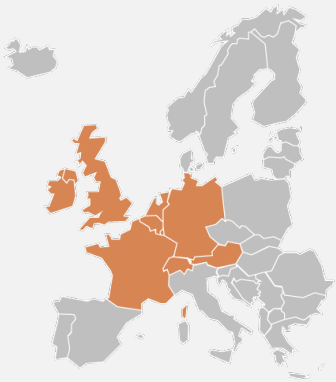


Image: nova-Institute

Why is it a good practice?

- Local recycling volumes of wood are increased on local level
- Wood is upcycled into furniture, which enhances the value of the post-consumer wood
- Furniture applications provide a good lifetime span so that the resource efficiency can be highly improved
- Increasing the public acceptance of post-consumer fibers within furniture is very important because these products are well-known and identified as high value wood-based consumer goods

Reuse, recycling and refurbishment of furniture

The furniture industry is a front-runner in waste prevention and resource efficiency. Creative and novel concepts of upcycling of wood reinforce the reuse, recycling and refurbishment of furniture. Viable collection and retrieval schemes of resources are needed for commercialization and market uptake. Buy-back schemes can be a solution to retrieve back the goods sold.

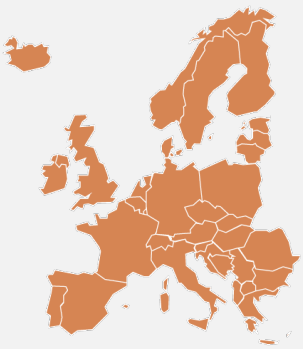
Image: Green Furniture Concept

Why is it a good practice?

- Recovery of resources in buy-back systems can be well-controlled, which also provides options enhancing the quality of the product
- Buy-back can still be named innovative and a new circular approach. Test loops will need to confirm feasibility of the method in the near future.
- Buy-back can be a financially viable option while the quality of the back-received furniture can be better controlled.
- In a closed-loop system the company can gain great resource efficiency
- Product lifetime and customer loyalty can be enhanced as warranty and buy-back provides high certainty to the customers.

Regional coverage and transferability

The upcycling of waste wood into furniture takes already place across all Europe. The techno-economically feasible solutions depend on the local conditions, the policy framework and supporting schemes such as buy-back. This is not particularly regionally-bound although the reverse logistics and acceptance in the region do play a role. Generally, the centralized collection points for furniture are lacking. Most of the furniture ends up in bulky waste or are incinerated.



Circular operational concepts

Since the circular economy concept focusses on resource, material and energy efficiency and is also service oriented, its development must be driven by improved value chain collaboration, co-creation, partnerships and platforms as well as practical business and operational concepts that improve circularity at the organisational level.

Most relevant WoodCircus indicators in this category

Business economic viability

The economic viability of many circular activities play an essential role for many actors to improve conventional and implement new business models. Therefore, organisational concepts are vital to make circularity a profitable and attractive alternative.

Waste management

Reverse logistics is a main feature of the circular economy that requires improvements in collection, sorting, pre-processing and material allocation activities. This has benefits for a whole network of actors and/or economic region.

Political and regulatory framework

Circular strategic and operational concepts can improve the legal state of the art of circular activities, which helps many actors as they face administrative burdens to improve their activities.

Social acceptance

Increasing public acceptance of circular operations and the attractiveness of circular systems and products is considered crucial for the advancement of circular strategies.

Climate change

Climate change and biodiversity aspects need to be embedded in the business strategies as they play a key role in the sustainable circular bioeconomy.

National Recycling Network for the collection, recovery and recycling of wooden waste streams

An Italian national consortium works on enhancing objectives concerning post-consumer wood packaging like palettes, boxes, crates, cages and reels for cables. The consortium is also involved in managing the recycling process for all wooden scraps such as industrial waste (panels cuttings, etc.) and urban waste (e.g. dismissed furniture). The recycling scheme implemented allows to recover also other typologies of materials, such as plastics, metals, paper, etc. .After collection and before mechanical treatment there is a separation process of different materials. The collection is carried out by common municipal collection as well as by private operators. The consortium works on non-profit base and is part of a national packaging consortium. All activities are contributing to objectives of national interest, in "guaranteeing sustainable production and consumption models".

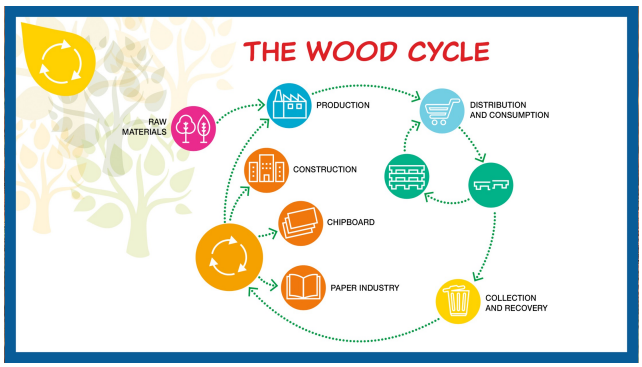


Image: Rilegno

Why is it a good practice?

- Production waste is prevented, and the performance of the packaging is optimized by extended and improved use of packaging in the cascading use
- Collecting waste from public, industrial and commercial sites as raw material for new products is upcycling
- Legal basis for wood packaging recycling is given
- Public and market acceptance of waste wood reuse is enhanced through the activities of the consortia
- Recovery, extracting raw material from the collected volumes is innovative technology
- Recycling and reuse, promotes the economy of products obtained from the recycling of wood.

Regional coverage and transferability

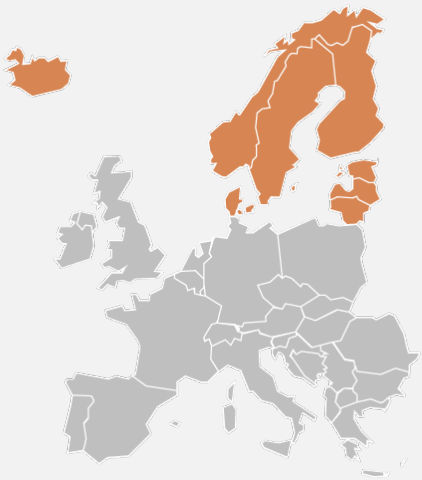
The national consortium for wooden packaging came to existence in Sothern Europe, where there is a lot production of heavy machinery and basically not much fresh wood. Machines are often packed into wooden packaging, which then also takes space to store. Therefore, the network might regionality-wise fit into many countries that have other post-consumer waste streams such as furniture. Also, different kind of municipals waste streams can be collected. However, higher barriers exist in the regions, that has the governance at a very regional level and for the waste streams no centralized systems are available.

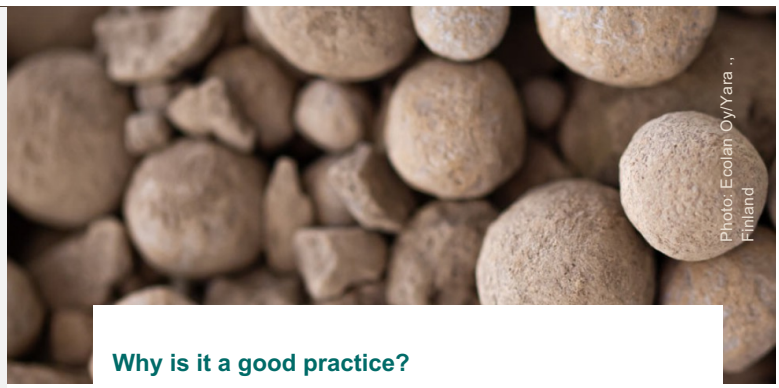
Ash and wood fibres for sustainable and lightweight concrete

Various stabilization techniques are used for recovered wood-based side streams in groundworks/foundations. Granulated ash processed to coarse-grained material from side streams of power plants replace the filling and filter layer of natural aggregate in road and field structures. Processed ash in aggregates replace cement as binders. The ash may come from bark, saw dust, and various types of wood chips. Natural aggregate in concrete can be replaced with discarded, clean recycled wood fiber by 20-50% of the product volume.

Regional coverage and transferability

District heating and power plants as well as small combustion plants using wood-based fuels generate significant amounts of ash as by-product as it is the case today in Finland. Ash from wood-based biomass is potentially applicable for many purposes, e.g. for infrastructure groundwork. Transferability is demonstrated in many European regions.





Why is it a good practice?

- Waste from incineration is recycled and re-used.
- The collection of waste from industrial sites as a raw material source for new products is upcycling.
- It replaces the layer of virgin sand used as frost insulation in road construction and infrastructure groundwork.
- Compared to conventional materials, products made of these materials are stronger, lighter and more ecological – environmental friendly.
- Recovering and stabilising waste materials is a smart, innovative technology.
- Recycling and reuse promotes the circular economy concept. New fibres from recycled wood can be processed to replace natural earth materials and cement, e.g., in paving and yard stones, and as a high performing material for noise barriers.

Multiproducts by integrating mechanical wood processing and cascading of by-products

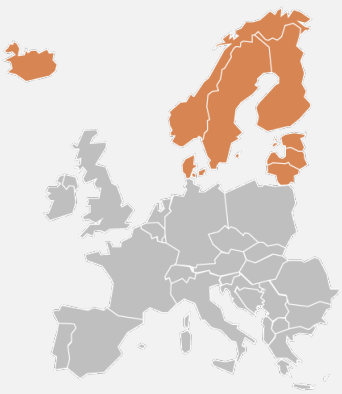
Integrated multi-production maximizes resource efficiency of wood raw material use by combining effectively side streams from the core business with co-production. Production plants are operating in the same compact industrial area, which brings synergies to processes and reduces costs and emissions of sawmill internal logistics. Bioenergy accounts for 98% of heat production. Chips from logging residues and wood processing by-products are used as fuel for own production plants and are sold to regional power plants. The higher-quality residue sawmill chip is sold to the pulp industry.

Why is it a good practice?

- All materials from harvested trees are used. Production side streams, e.g. chips and sawdust, are both used in own chipboard production and/or are sold to contract customers as raw materials for pulp and energy production.
- It enables further processing of side streams into value-added wood panel products within the same company.
- It provides readiness to adapt the demand for new uses of wood (e.g., advanced biofuels, extractives and other bio-based products).
- The needed energy for own and regional use is produced in the company's biopower plant with forest chips or circulated wood chips.
- The core businesses have been diversified into sawing and plywood plus particle board manufacturing, resulting in optimal material efficiency. Direct connection to prefabricated house industry increases material efficiency in the wood construction sector.
- Optimal location of production plants in relation to the wood procurement area, optimal wood species ratio mix in the wood use at plant, and often own wood procurement are advantages for cascading use of raw materials that leads to profitable operations.

Regional coverage and transferability

Industrial symbiosis networks can be found in Northern Europe today. These co-production networks include wood resources also energy recovery from waste particles. They achieve high efficiency in processing. Situated in Finland today, transferability is possible in other areas of the Europe (and worldwide) where framework conditions match raw material availability. The integrated entity can adapt as needed to replace old production as new business opportunities emerge. A peculiarity is related to the fact that Finnish legislation supports cascading use in bio-energy with regional partners. A supportive legal situation of such network can help to attract such new actors.



Energy recovery system for treated wood

The Finnish wood impregnation industry is a pioneer in organizing the recovery of (impregnated) wood. Impregnated wood waste generated in households can be brought free of charge to collection points of building materials stores and waste facilities. A waste treatment fee is charged for all industrial returns. Impregnated wood is safely utilized for energy in combustion plants specializing in the treatment of impregnated wood. A non-profit company is working merely to cover the costs of recovery. The operation is funded through recycling fees.

Regional coverage and transferability

Finland has an internationally unique collection and recovery system of impregnated wood for households and companies. Decommissioned wood must not be burned in home fireplaces but must be delivered to the impregnated wood collection points of timber stores or waste facilities.

The network is transferable in other European region if similar support for the cooperation in networks is available and the use of treated wood is on a reasonable level.

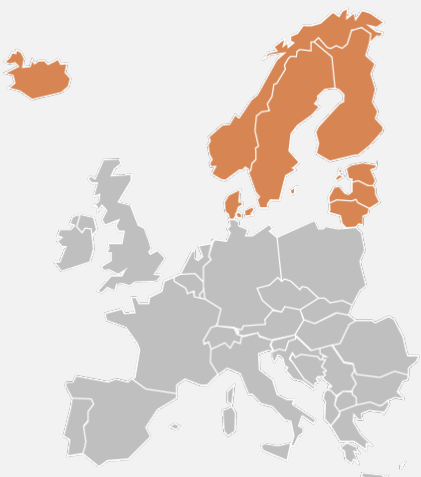


Image: The Finnish Wood Preserving Association

Why is it a good practice?

- Impregnated wood is a recoverable product that can be used for energy production by burning it in approved industrial incinerators.
- According to Finnish national environmental legislation, impregnated wood using creosote, CCA and Cu compounds are a separately collected waste.
- Recovery provides consumers and industrial participants with an effortless and practical way to dispose of excess impregnated wood.
- The network supports companies' compliance with their obligations under EU REACH to identify and manage the risks linked to the chemical substances used in impregnated wood.
- Recycling terminals and waste treatment plants across Finland receive waste wood from companies and specialised organisations.
- Direct transportation to the recycling company's recycling terminal is usually the most economical way to return decommissioned impregnated wood and guarantees the positive public perception.

Local industrial symbiosis in the wood construction value chain

Industrial symbiosis is a collaborative network of diverse organisations that can foster eco-innovations and long-term business culture development, create and share mutually profitable transactions, acquire services and improve business and technical processes together. A local industry park in Northern Finland is a good example of long-term collaboration and partnership between 15 private companies and a municipal RTDI unit. The primary and secondary products produced form a wood construction value chain, where side streams, excess materials and energy are aligned in the context of the bio-circular economy. The network covers sawn timber, planed wood and components, planar and space elements, CLT panels, elements and modular units, log houses and windows. A construction company, design services, CHP plant, pellet factory and three manufacturers of value-added products from wood-based side streams complete the network. The municipal unit supports the industries by organising education and special courses, providing a practical training environment for woodworking and establishing collaborative RTDI projects to accelerate innovations. It also runs the Triple Helix network of the companies, research institutes, schools and universities involved.

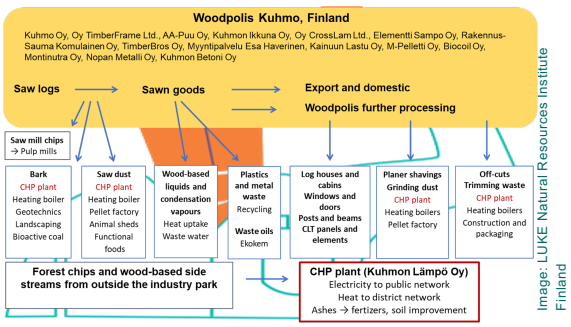


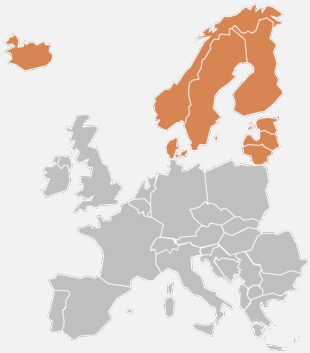
Image: LUKE Natural Resources Institute Finland

Why is it a good practice?

- Local sources of raw materials and high utilisation rate of side streams contribute strongly to the circular economy concept and the sustainable use of biomass
- An integrated industrial park provides to a network of companies a strategic and functional platform for business cooperation and marketing initiatives in the circular bio-economy, especially for SMEs.
- Networking between primary and downstream processing companies, side stream producers and users enables to integrate research partners for strengthening RTDI activities
- Opportunities for high-level optimisation of products and side stream utilisation leads to high resource and energy efficiency as well as to closed material and energy loops.
- Foresight of and flexible adaptation to legislative changes can be achieved in due course.

Regional coverage and transferability

Local industrial symbiosis is a way to overcome the challenges of remote location from the main markets and customers for individual companies here specifically in the wood construction value chains by providing an efficient material and energy network. Market competitiveness, product and technology development, eco-design, branding and adoption of regulation and cascading ideas for circular bio-economy is reinforced and benefit from local collaboration and endorses investments and fund raising. The local industrial symbiosis is a concept that is highly transferable across all European regions.



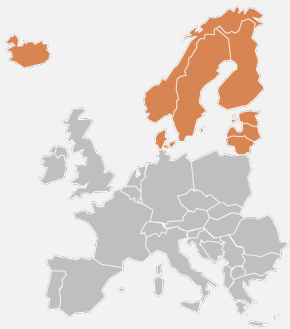
Large-scale industrial symbiosis of sawmill, bio-refining and side stream utilisation

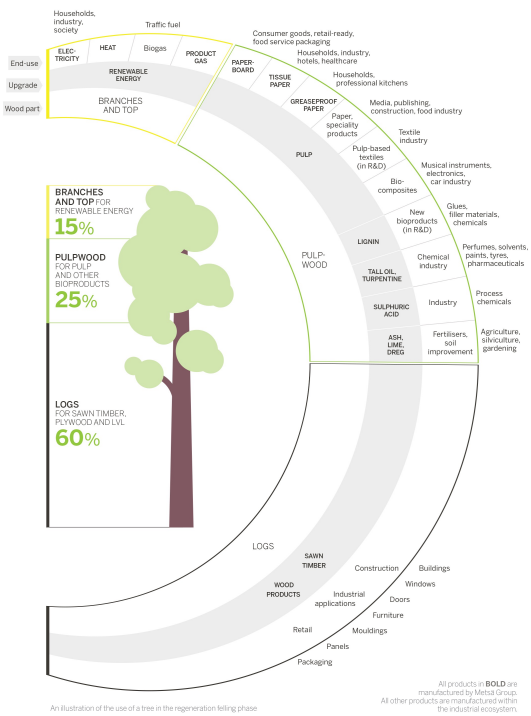
Pulp mills, paper and/or board mills as well as sawmills of large forest companies, located at the same site or near to each other, create industrial symbioses where the raw materials are procured by a mutual organisation. Sawmill residues are efficiently processed at pulp mills and in bio-energy production. The side streams and waste from pulp production, paper and board mills are bio-refined to value-added products.

A large variety of circular bio-products and bio-materials are manufactured with optimised resources and close-to-zero-waste loops of materials and energy. Local logistics are organized commonly for organising energy, fresh- and waste water, as well as emission management, all driven by the pulp mill for the other companies and production units.

Regional coverage and transferability

Industrial symbioses located around pulp mills are common in Northern Europe. They increase competitiveness, reduce risk and enhance financing possibilities for product and technology development, eco-design, branding, and spin-offs. They are often willing to adopt the regulations and cascading ideas of the circular bio-economy. The symbiosis requires skilled human and economic resources as they are based upon collaboration and trust between companies. This model can be applied across Europe if stakeholders are interested and willing to invest and collaborate into it.





Why is it a good practice?

- Close integrated production lines with a strategic and functional platform for efficient utilisation of virgin wood and side streams in cascading, recycling and material processes.
- Mutual business and RDTI collaboration with spin-offs and potential for enhancing the value-added systems within the circular bio-economy and bio-refining.
- High resource efficiency, surplus of net energy balance, closed loops and minimal material-, liquid- and gaseous wastes.
- Sawn timber for construction and furnishing uses have long life cycles, low carbon footprints and high re-use potential.
- Financial safety, investment capacity, economic viability and raw material availability of large industrial consortia.

Efficiency and processing

High process and material efficiency are features of well-functioning value chains and are also pathways to well-balanced, effective and cost-competitive use of wood resources as well as side streams. The optimized use of raw materials is an important feature of resource efficiency in processing industries.

Most relevant WoodCircus indicators in this category

Purity of products

Machine technology and process optimisation contribute to the reduction of undesired substances, such as glues and chemicals. This is a prerequisite to enhance the recoverability of materials.

Innovation

Technology and process innovations enable optimising the use of raw materials. Techno-economical feasibility increases the yield and reduces the waste at the same time.

Waste management

Expanding the valorization of side stream-based products advance waste management operations.

Sustainability of wooden biomass

Securing product sustainability by sourcing virgin wood from labelled forest management schemes as well as with optimal use of side and recycling streams.

Energy efficiency

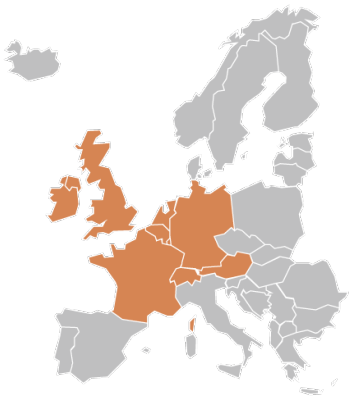
Substituting fossil-based energy with carbon-neutral energy sources and reducing the overall energy consumption in the processes contribute to the energy efficiency and carbon footprint targets.

Reuse of low-density fibre-boards for insulation use

Fibreboard is a type of engineered wood product that is made from wood fibres. Structural cohesion is essentially based on the interlacing of the wood fibers with a small amount of binder. Demand for wood fibre insulation boards is increasing to meet all requirements for building facades in multi storey, residential- and public buildings, in rural and urban areas.
Small amounts of binders and several types of additives (to improve their fire properties and water repellency) are necessary to enable use in multi-story buildings. A mixture of untreated fibers containing post-industrial and recycled wood chips and shavings, as well as wood that has been harvested and grown according to sustainable forest management practices can be used.

Regional coverage and transferability

Leading companies are today identified in Central Europe.
The practice can be transferred and manufactured in other regions where they have access to untreated wood resources including post-consumer wood.



Why is it a good practice?

- The use of 100% untreated recycled wood as raw material is technically possible and provides a high added value to recovered wood as a source. Wood fiber products are completely recyclable and can be disposed and collected at recovery centers.
- Some producers of insulation fiberboards collect used panels to be processed and reused in the same application.
- Among insulating materials made from renewable raw materials, wood fiber insulation boards are the most common, along with cellulose, hemp and flax short fibreboards.
- Wood fibreboards are known for their low volatile organic compound emission ratings. The improved indoor air quality improves public acceptability of these products.

Hard Density Fibreboards- Hardboards‘ enhanced circular use

Hardboards (i.e., high density fibre – HDF – boards) are panels that can’t be made purely from recycled wood due to the necessity of fresh fibres needed for the wet processing technology for producing them. Hardboards can be used in almost all interior applications. When processing with wet technology, the lignin from fresh wood acts as a natural binder, which makes the boards non-toxic, recyclable and reusable. With no added resins, the formaldehyde content is the same as it is for natural wood. For this reason, this technology is a circularity enabler. The hardboards can be used for various indoor application fields including furniture components, wall panelling, moulded door skins, underlayment, perforated boards and others. This enables broader end life options and enhances resource efficiency of the overall production.

Image: nova-Institute

Why is it a good practice?

- Reduced use of chemicals since no resin is used
- The feature of the hardboards without synthetic resins enhances waste management options, reuse and recycling while reinforcing already eco-design
- Resource efficiency is improved by better cascading, reuse and recycling options
- The public is made aware about resin free alternatives, which teaches and increases understanding of circularity requirements
- The environmental footprint of the boards is optimised through reduced emissions
- Large potential for use in indoor applications where high emission standards are required

Regional coverage and transferability

Several companies that manufacture hardboards have been identified across Europe. Since the boards are used in so many applications, of which many are interior design, the target market is not dependent on the location of the production facility. It therefore can be said that the technology can be used and transferred widely.

Structural engineered wood for construction

Engineered wood products (EWP) are contemporary composite materials, which exhibit high physical and mechanical properties. They can be used as columns, beams, walls, roofs, ceilings and other building components. EWP are made from a variety of wood pieces in various shapes that are either bonded by a high performing adhesive or are mechanically fastened. Many different types are currently produced, including plywood (glued sheets of laminated veneers with alternating grain direction layers), cross-laminated timber (CLT, made of cross-stacked timber planks bonded together under high pressure), glued laminated timber (glulam, composed of several timber layers glued together with high-performance adhesives), laminated veneer lumber (LVL, glued thin wood veneers) and oriented strand boards (OSB, oriented rectangular-shaped strands of wood).

Regional coverage and transferability

Manufacturing companies of EPW have been identified across Europe. The products are structurally sound and suitable replacements for other construction materials. EWPs are even suitable for multi-storey buildings in any region as they can provide high fire resistance and seismic safety. As such, they are increasingly used in areas with strong winds and high seismic safety demands.

Image: Gabberó

Why is it a good practice?

- They are designed and manufactured to maximize the inherent strength and stiffness characteristics of wood, making more efficient use of wood, as they are made from smaller pieces of wood
- They are industrialized innovative products and thus can be manufactured as ready-to-use elements or systems and then be delivered to construction sites reducing on-site assembly time.
- They enable the load-bearing capacity of timber panel elements in both directions, increases load-bearing capacity and limits splitting while ensuring the dimensional stability of panels.
- They improve awareness for wood as a suitable alternative for high-demand architectural designs and just-in-time production of buildings.
- Reuse of engineered wood is possible, but regulations for their usage must be developed.

Old technologies support circular innovation

Old technologies, such as a centuries-old, traditional Japanese method, can support circular innovation. By charring under defined conditions, the wood surface is carbonised resulting in altered properties. This refinement method eliminates the need of chemical treatment with wood preservatives and ensures fully reusable and recyclable of wood products. Apart from this, carbonisation can achieve wonderful wooden designs that can be applied in architecture and interiors. From this practice, we learn that certain culturally distinctive techniques never get outdated and can even be re-vitalised as novel circular approaches and appropriate (pre-)treatment methods.

Why is it a good practice?

- Cascading usability of the material is enforced
- For the surface treatment no chemicals are needed so that overall purity of the product is improved and remains
- Innovative waste management operations are made possible as wood is fully reusable and recyclable
- With treatments like this, sustainability of biomass use can be improved
- Public acceptance and awareness for alternative treatment methods of wood can be achieved by façades and other visible applications

Regional coverage and transferability

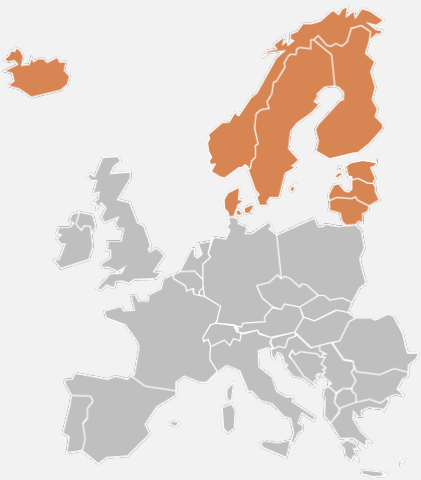
Carbonising wood is an ancient technology from Japan. The technology itself should know no regional barriers in Europe. The combination of charring and an oil treatment eliminates the need for chemical preservation of wood. The simple process makes the technology easily transferable to board production. Similar technologies may be apparent in other regions where wood enjoys a special cultural value.

Intelligent sorting system for recycling industrial, construction, demolition and packaging wastes

Applying artificial intelligence AI and robotics, identification and sorting of different types of wastes becomes more accurate, efficient, productive, reliable and economical viable, including wood-based wastes. In this specific case, the system provides both, “eyes and hands” with powerful sensors, smart trainable software and efficient heavy-duty robotic arms for municipal, private and industrial waste management operations. The system is designed for separation of wood by grade (A/B/C/D), metals, rigid plastics (mixed or polymer), inert mixed fractions and types of construction, demolition, industrial and packaging materials (bricks, concrete, stones, paperboard, etc.).

Regional coverage and transferability

The innovation and technology was developed in Finland for the needs of municipal and private waste collection and management centres at local and regional levels. The company, founded in 2007, is the first to apply AI-based sorting robots to a complex waste sorting environment. The system is currently in operational use on four continents globally already, therefore the technology can be further transferred to improve the value chains performances across Europe.



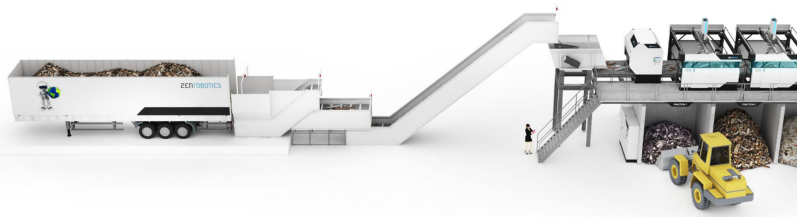


Image: ZenRobotics Ltd.

Why is it a good practice?

- Increase accuracy, efficiency and economic viability of waste sorting, which makes recycling more profitable
- Decrease the need of pre-sorting wastes at construction, demolition, industrial and commercial sites
- Simple and energy efficient process with low operating costs
- Increase in the yield and allocation potential of cascading materials, instead of incineration or landfilling
- Advanced, unbiased detection and separation of hazardous materials with environmental or health risks
- Replacing manual processes and improving occupational safety
- System can be tailored to waste collection and management centres of different sizes and volumes
- Self-learning and trainable software technology provides continuous development to separate different material fractions and expand the recyclable material palette

Integration for resource efficiency and circular operations

A northern wood company has developed an integrate in which three business lines make the most out of resources by adaption of circular operative models. Woodchips are grinded into chemi-thermomechanical pulp, which is used as a raw material for the middle layer of paper-board. In the pulp mill, sawdust is cooked into cellulose pulp, which is then used without bleaching as a raw material for saturating base kraft papers. Furthermore, old corrugated containers are processed into fibres, which are used as a raw material in the production of the saturating base kraft papers. The black liquor created as a by-product of cellulose pulp production is utilised in the energy production of the mill. Lastly, nutrients such as nitrogen and phosphorus, generated as a side stream in production are recovered for use in farmland.

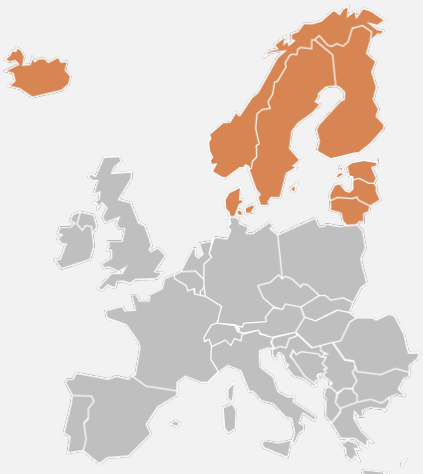
Image: KotkaMills

Why is it a good practice?

- Wood pulp in is used with high resource efficiency as sawdust is cooked into wood pulp.
- The level of recycling of the saw dust used pulp and the corrugated containers for the saturating kraft papers as well as nutrient recycling shows optimized waste management operations.
- Since black liquor that is generated by the production is used to power the plant, the business model also presents high energy efficiency.
- The business model of the three plants that is based on industrial symbiosis and exchange of wooden waste to create materials and energy is innovative.

Regional coverage and transferability

Especially in the wood intensive Northern European countries, integrated way of operations have potential for creating energy and material efficiency, as well as recirculation of materials for reuse. However, realization of such efficient production ecosystems require new partnerships and high commitment. Furthermore, establishment of circular integrates require favourable regulation that often take years to achieve.



Waste and side stream valorisation

The concept of the circular economy adds value to the waste and side streams by opening further opportunities along wood value chains.

Most relevant WoodCircus indicators in this category

Innovation

There are many possibilities for innovative solutions regarding the functional use of side streams. Early adoption of CE marking and requiring Life Cycle Assessment (LCA) and Product Environmental Footprint pay off.

Waste management

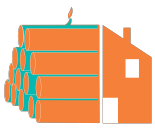
Novel material and advanced bioenergy uses of side streams can bring advancements to regional waste management systems, even beyond the companies directly involved. New kinds of semi-finished and end-use products need to be developed to the established recycling streams.

Political and regulatory framework

More and more knowledge transfer is needed to improve the legal status of co-production in wood processing industries and demolition waste utilisation from construction.

Social acceptance

Acceptance of products from wood-based secondary raw materials and waste materials can be driven with products substituting the use of non-renewable materials. These may have wide impacts at the consumer level as well with industrial end-users and public purchasing bodies.



Resource efficiency

Cascading use and utilisation of side streams help to keep wooden material in use and to improve resource efficiency of wood resources further.

Economic viability

Industrial side streams bring economic benefits and monetary flows to wood processing, packaging and furniture industries already. There is a high potential to increase added-value and income by upgrading material quality and launching new products to the market.

Circularity in manufacturing of prefabricated houses

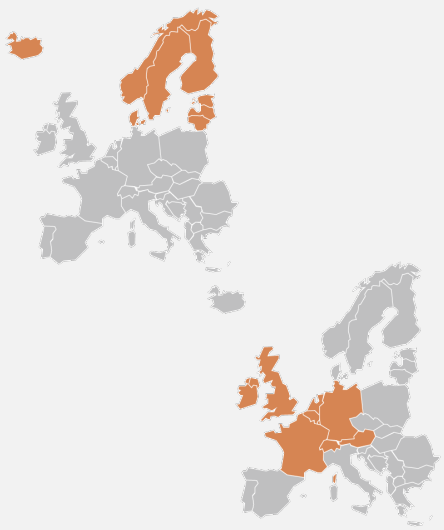
Manufacturing prefabricated houses with a circular approach represents a sophisticated concept. As an example, the insulation material generated from sawdust in the production process can be processed into a complex and yet profitable product reinforcing resource and energy savings.
High degree of prefabrication, integrating the drying processes, improving accuracy of the processes, speeding-up the installation phase, and guaranteeing safety of the final product are all key factors that strengthen the competitiveness of wood construction. It enlarges the capacity to build eco-and energy positive houses.

Why is it a good practice?

- Prefabricated houses offer great possibility for enhanced use of wood as a replacement of other construction materials with higher environmental impacts by allowing significant material savings, waste reduction, and reuse of components in wood construction
- Recycled material use provides high circularity advancement with improved raw material use and availability of side streams for production of components such as wooden insulation panels
- It demonstrates a sustainable solution with reduced emissions and a long lifetime of wood-based buildings due to better recycling options
- Improves consumer awareness of more sustainable prefabricated housing options
- Legislative situation fosters the use of prefabricated wooden houses around Europe

Regional coverage and transferability

A market feasibility study for Northern- and Central Europe predicts a huge market for prefabricated houses (before Covid-19 Pandemic situation). However, since the price-quality ratio and brand perception is considered as the most essential buying criteria, the transferability can be traced to all macroregions.

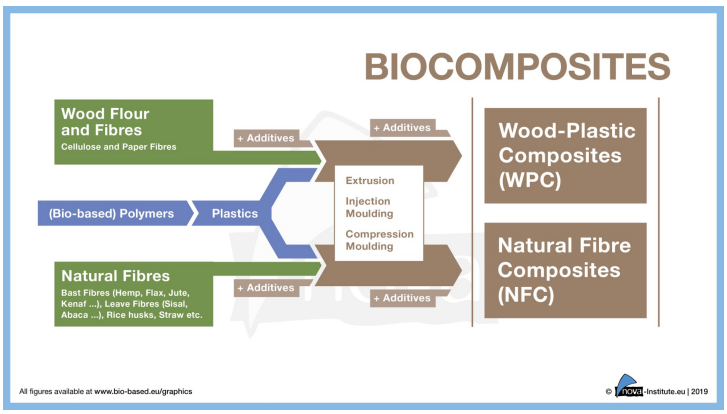


Recycling system for biocomposite decking

Biocomposite is a collective term referring to fibre-reinforced materials with partly natural origin. Fibre content ranges from 15% to 75%. Decking materials for outdoor applications is the biggest market segment for biocomposites produced from local sawmill side streams. The thermoplastic end product is recyclable and several Wood Plastic Composite (WPC) producers promote “a take back system for wood-plastic composites”. Innovative producers invent their own system for collection. Consumers return products to the dealer with recycling take-back boxes or order boxes at home. Taken back products reprocessed and made reusable as decking boards again.

Regional coverage and transferability

Reverse logistic practices are feasible and economically viable for many recyclable products as described here for decking boards. The transferability is depending on the market demand and the occurring volumes in regions.



Why is it a good practice?

- High percentages of postconsumer material can be used and upcycled as e.g. decking material for a second life
- Waste management with a take-back system drives market acceptance of these recycled products and adds value for environmentally friendly products
- Innovative solutions and functional use of side streams such as for outdoor decking improves biomass profitability
- Decking products can have a lifetime guarantee of 10 to 25 years, which is rather durable for outdoor products and therefore presents an advantage compared to common practices of solid wood decking
- Developing new recycling systems inherits advantages for the whole value chain

Biogas from wood-based residues at waste management centres

Biogas is derived from a multitude of organic waste materials from public and private waste management centres in Northern Europe. Wood bark from industry, urban wood residues, household waste, some construction-, demolition- and packaging wastes, also low-value forest residues are processed after sorting and mixed with other organic materials by anaerobic digestion (fermentation). The resulting bio-fuels (as liquids) are used in vehicles, district heating networks and local electricity consumption, as well as process gas in miscellaneous industrial processes. Fermented waste materials from old landfills are used in the biogas process as well. The fermented and fresh forest industry waste can be transformed into fertilizers and other value-added products.

Regional coverage and transferability

The basic raw materials for biogas can be found everywhere across Europe and some wood-based wastes can be mixed with other organic wastes. Technology is available for different scales of production.

The market potential of biogas products is positive both for legislative reasons (fuels for land vehicle and ships, peat restrictions) and for the increasing industrial demands and opportunities across sectors and regions. Fermentation waste materials, upgrading environmental efficiency and improving the carbon footprints make biogas attractive for waste management centres.

Exploitation within and across Europe is given, but should be accompanied by market feasibility studies at local and national levels. Development of distribution networks and further improvement in material efficiency and testing for local or specific wood materials (lignin-rich materials) can accelerate implementation.

Why is it a good practice?

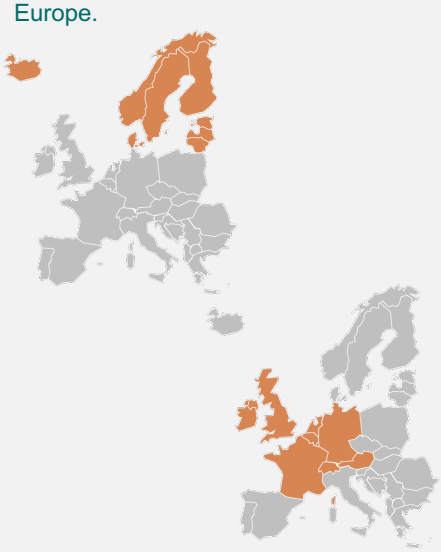
- Innovative, safe, environmental friendly and closed-loop production technology that can be applied in various scales of production and in different industrial environments
- Contributes to substitution of fossil fuels and peat
- Raising public acceptance of wood waste management for value-added products
- Improving restoration of old landfills and providing solutions to avoid landfilling

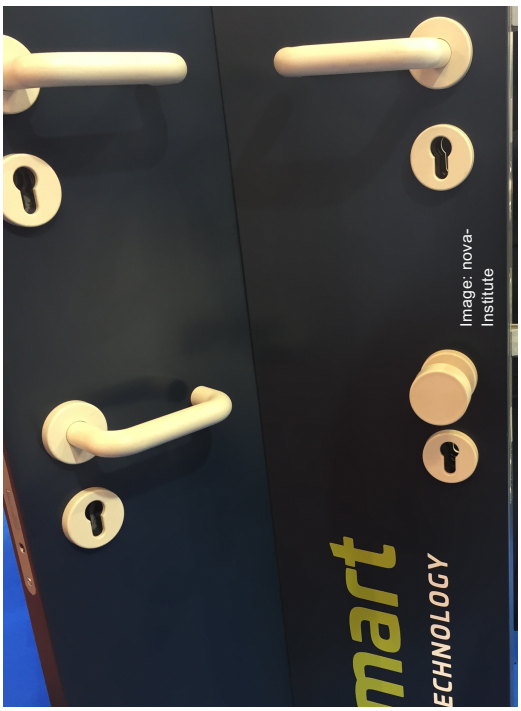
Antibacterial composite materials from wood side streams

Biocomposites are used in vast number of applications: consumer goods, toys, handles, shoes, façade and terrace elements, floors, automotive interiors, and even space applications. The use of bio-based fillers and reinforcing materials reduces the amount fossil carbon in the composite materials. According to ISO 22196 standard, the fibres from pine wood (*Pinus sylvestris*) possess antibacterial compounds, that provides added value to the fibre-reinforced biocomposites. Currently, the antibacterial property of the pine fibres is exploited in biocomposites designed for toys and materials for construction interiors.

Regional coverage and transferability

The wood processing companies are selling fibres and side streams for different applications across the Europe. Wood processing side stream exploitation and valorisation are currently local processes, predominantly occurring in Central and Northern Europe. The valorisation of low cost and low value resource to added value products is highly transferable to all wood processing countries in the Europe.





Why is it a good practice?

- The use of pine wood waste and side streams in added value, innovative and profitable products
- Replacement of fossil material (plastic) with renewable material in the composite products
- Reduction of greenhouse emissions

Pencils made resource efficiently in Europe

The company uses bio composite material to produce pencils and crayons from a single cast: three granulates - one each for the surface, the body and the lead of the pencil - are produced in a one step process. This can be achieved by binding and recycling spruce fibres with a polymer matrix material and a special developed co-extrusion process which joins all pencil materials. Conventional manufacturing methods for pencils and crayons take up to 30 process steps and pencils are often made from non-European wood. The company started selling WOPEX-based pencils in 2009.
Today steadily growing share of the company's pencils and crayons are made from this material. This process is still revolutionising pencil manufacturing in terms of production time, costs and new opportunities for innovative products.

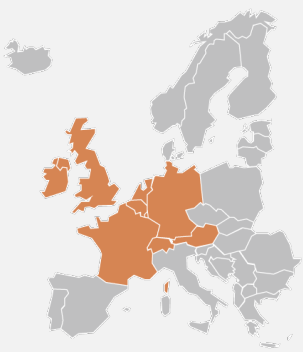
Image: Staedtler

Why is it a good practice?

- Utilisation of high percentages of side-stream material from woodworking industry enables a further stage of re-use and cascading and as a result small parts from the tree can be used in the pencil industry.
- Spruce side streams are upcycled into pencils presenting a functional use of material side streams adding value to the product.
- The innovative production process eliminates waste that would be generated by traditional woodworking.
- The use of energy and emissions from the production process is minimised through optimised processing that reduces the number of usual multi-production steps.
- The modern manufacturing process makes this pencil particularly robust, which can be seen in the high break resistance of the lead.
- Pencils with better usability than the traditional pencils are products that can attract wide consumer acceptance enhancing consumer attention to bio-composite materials.

Regional coverage and transferability

So far, this good practice is mainly traced to the Central European region, where pencil producers have implemented biocomposite materials to replace virgin wood. The granules that are used for the pencil production are a basic material for different applications beyond the writing instrument industry and it has been tested in other products as well. This allows to predict a high transferability to other consumer products to be produced across Europe.

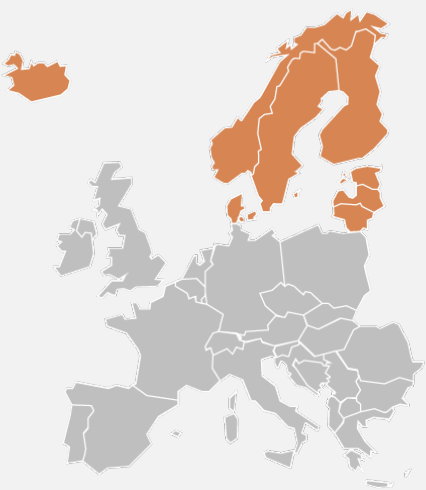


Biochar as a soil amendment

Biochar from wood-based materials is a charcoal with more than 60 identified uses when it replaces coal from the earth and peat. It has potential, especially as raw material for forest fertilizers, as it contains phosphorus, potassium and calcium, which are important nutrients for tree growth. It can be particularly used in degraded soils. It is used in greenhouse production and tree nurseries where it replaces growth peat. It is an efficient carbon sink as one metric ton of biochar binds 3.7 tons of CO2 and carbon of biochar mineralizes 10 to 100 times slower compared to uncharred biomass. Furthermore, the technology is reliable and emission-free. It is a good use for wood residues and clean waste wood. More than 60 uses have been identified (e.g. replacing peat as a growing medium for tree seedlings). During manufacture, nutrient granules can be added to the biochar. Eventual potential risks regarding the formation of harmful organic compounds can be minimized by adapting the processes accordingly.

Regional coverage and transferability

Biochar for soil amendment has reached the commercial production in Northern and Central Europe.Biochar has the potential to enhance soil functions related to nutrient and water balance as well as soil reaction and productivity of high importance to fight climate change impacts on forest soils.



Images: Fernando Urbano Tenorio and Johanna Nikama (Luke)

Why is it a good practice?

- Improves the capacity for higher value applications of wood residues beyond only thermal recycling
- The manufacturing technology is reliable and emission-free
- Improved biomass sustainability by optimized growing conditions and carbon sinks
- Carbon sequestration is a main innovation driver, which can enable many process, product, management and governance-oriented changes
- Improving public acceptance to think in carbon cycles is essential and will lead to improved sustainability
- Advances the legislative situation for carbon sequestration
- Contributes to tackle climate change!

From sawdust to packaging and tissue

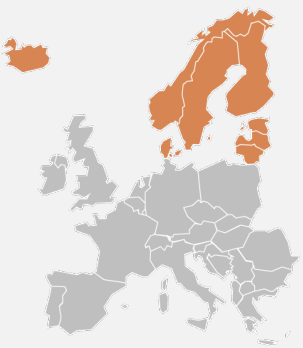
In view of a circular bioeconomy, we must start rethinking the packaging of products. Biodegradable, non-plastics food packaging and catering products are a good example of environmentally friendly and sustainable products, which can substitute fol. Therefore, it is needed to work with improved take back systems to offer solutions with genuine environmental impact. It is seen as a very profitable together in smart partnerships and in order to optimize value chains. A good example for keeping sawdust biomass in use is presented with sawdust that is treated to special pulps so that it can be used for plastic free packaging. After disposal from the consumer the packaging can be recycled into special kind of tissue. Thereby, resource efficiency can be improved.

Why is it a good practice?

- Using wood pulp in these applications is better than incineration because resource efficiency can be improved
- The practice is seen as economically feasible, especially in view of the take back system by which even more packaging can be recycled
- These practices were enabled by a much effort driving the regulation of the take back system forward
- Overall, this system can achieve highest market and public acceptance for biodegradable packaging and recycled tissue

Regional coverage and transferability

Packaging from sustainable sources is driven more and more as it is on the one hand on the political agenda and on the other hand demand for packaging without plastics is also seen from consumer side. From this point of view, waste and side-stream valorisation of sawdust for packaging can be seen as economically promising way of upcycling and transferable to other businesses. The presented case of sawdust that is processed into pulp for packaging, which can be used for tissues is a regional case of the Northern macro-region. The network operates at a very regional basis. However, the cascading principles of such case are not regionally dependent.



From sawdust to mycelium for insulation and packaging

Sawdust can be used as a substrate to grow mycelium. Generally, mycelium has the potential to utilize any kind of substrate like logs, cardboard, straw and wood chips. Nevertheless, especially for side-and waste streams such as saw dust it creates new possibilities for meaningful applications. In line with the cradle-to-cradle idea, a growing number of bio pioneers experiment with mycelium. Particularly mycelium-based composites used for sound and thermal insulation have a very low carbon footprint compared to other materials used for these purposes. Next to this, mycelium grown from sawdust can be used as bio foams replacing polystyrene (EPS), which are normal lightweight crude-oil based packaging materials. Thereby, the utilization of sawdust as substrate to grow mycelium is not only a way to increase circularity of building and packaging materials but also to steer to a natural and fossil-free environment.

Regional coverage and transferability

Growing mycelium is a very old technique. Gourmet mushrooms, which can also be grown in a saw dust substrate, is basically practiced in any part of the world. In eastern Asian cultures such as Singapore also the tradition of fermented mushrooms, clearly belongs to the cultural heritage. However, the current movements of growing mycelium composites that can be used for packaging or insulation can hardly be located within Europe since many pioneers have started experimenting at the same time. For this reason, this good practice is not particularly bound to any region. Developments can be seen anywhere in the world. Growing mycelium in saw dust can be transferable in need of those characteristics.

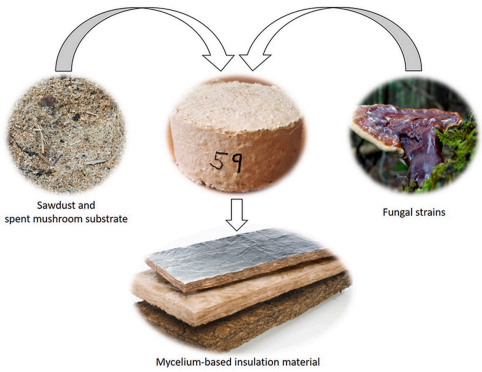


Image: Helge Schmitt, Stephan Voß, Daniel Pleissner, „Spent mushroom substrate and sawdust as precursor material for mycelium-based thermal insulation composites", Journal of Cleaner Production Vol. 313, 2021, ISSN 0959-6526

Why is it a good practice?

- The utilization of saw dust as substrate to grow mycelium creates new business opportunities, which will lead to less saw dust that is burned or wasted without any useful application.
- The collection of saw dust from sawmills needs enhanced waste management operations.
- Bio pioneers experimenting with mycelium have initiated a very innovative movement leading to more and more co-creation.
- Resource efficiency is enhanced since the wooden materials are kept in use – not as wood but as a new evolution.
- Growing mycelium can be done causing basically nor harmful emissions. Next to the biowaste only small amounts of water are needed and just when the mycelium is there the organism is killed by heaters, which has only little climate impact.

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