CASCADES

'Study on the optimised cascading use of wood'

Executive Summary

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Abstract

Cascading use is the efficient utilisation of resources by using residues and recycled materials for material use to extend total biomass availability within a given system. Cascading at the market level (sectors and products) can be quantified through *wood flow analysis.* The cascading use of wood takes place in the EU in a variety of forms and contexts. To realise its full potential multiple barriers to cascading need to be overcome. These exist to both the provision and utilisation of wood and include technical barriers, such as cleaning of recovered waste wood; market barriers, such as the dependence on upstream products; and governance barriers, such as the lack of integrated approaches towards energy and material applications of biomass. Overcoming these barriers will require a mix of approaches depending on specific local circumstances. Identified measures to promote the cascading use of wood focus largely on the recovery of post-consumer wood in line with existing circular economy and resource efficiency initiatives. However, strong efforts are needed to address the current imbalance between material and energy uses of industrial residues where more significant potential for cascading exists.

Executive summary

Introduction

Wood as raw material provides for a broad variety of human needs including construction materials, textiles and fibres, paper, chemicals, and energy (heat, electricity and fuel). The technological possibilities to utilise wood in new and more novel applications are increasing significantly in all these areas. Wood can be a sustainable resource and help contribute towards the development of the circular and bioeconomy in which it is already playing a key role. Wood, and Europe's forest resources, on which wood supply depends, is a finite but functionally renewable resource. The demands for wood and wood-based products as well as other services provided by forests are increasing, partly with a growing global population, but also from changes in political agendas with renewed interest in the bioeconomy and increased deployment of biomass to meet renewable energy targets. To meet these demands sustainably requires action in a variety of areas, from the sustainable management of forests and a balancing of the services they provide, to the more resource efficient use of wood in society. In this study the possibilities of increasing the availability and utility of wood through improved and optimal cascades are investigated.

Objectives

The objectives of the study are to define the cascading use of wood and assess the environmental and socio-economic impacts of cascading, to identify and analyse the barriers preventing cascading and the possible measures adapted to local conditions to overcome them in the European Union (EU). The results of the study are intended to serve as a basis to develop good practice guidance on the cascading use of wood to policy-makers and value-chain stakeholders.

Defining cascading use

Following over 20 years of research in this area, the literature includes a wide range of different definitions of the term 'cascading use'. Most of those identified for this study relate to biomass, where wood is the most frequently analysed form. In this study cascading use is defined as ***"the efficient utilisation of resources by using residues and recycled materials for material use to extend total biomass availability within a given system"***. From a technical perspective the cascading use of wood takes place when wood is processed into a product and this product is used at least once more either for material or energy purposes. In a single stage cascade, wood is processed into a product and this product is used once more for energy purposes; in a multi-stage cascade, wood is processed into a product and this product is used at least once more in material form before disposal or recovery for energy purposes. In this study specific attention is paid to multistage cascading, as this includes the challenge of recovery and utilisation of used wood.

Quantifying cascading use

Almost all definitions identified in the literature review focus on technical processes in a production line or in a factory. These definitions are helpful to get an understanding of the technical aspects of cascading. However, there is a big difference between a production process in a factory and the transactions that take place in the market. In a factory scenario, all information is typically available to calculate different steps of cascading, as long as they take place in one factory. As soon as materials and/or products leave the factory and are transferred between market partners, calculations become significantly more complex due to the lack of data. It is not possible to trace and report all market transactions, where several producers purchase products with different resource compositions at different times. Instead, in this study a calculation

scheme of cascading use at the market level is introduced to help policy makers to understand what an optimal market framework might look like, using available statistical information and wood flow analysis. The method recognises that provision of wood for further cascading is as important as utilisation of residues and recovered wood, and provides a method to determine residue and recycling input and output rates at the market level of semi-finished products such as particleboard, fibreboard etc.

Each region and country has specific conditions to provide and utilise residues and recycled materials. The main influencing factors are forest productivity in relation to population, wood industry development and consumption, as the basis for recycled material. In general the provision of cascading material does, more or less, lead to its utilisation (elasticity close to 1). The difference between provision and utilisation is due to existing industries using cascading material (particleboard industry as well as waste paper mills). The availability of post-consumer wood and the scarcity of primary biomass have a strong influence on the utilisation of post-consumer wood (cascading) in certain countries. The cascading use of wood is also strongly related to the material utilisation of softwood, due to current market structure and industrial processes oriented towards utilising softwood resources. In contrast, hardwood utilisation has almost no influence on cascading.

Understanding the barriers to cascading

In order to understand the possibilities and barriers to increased cascading use, a number of case studies were undertaken. These include: the utilisation of construction and demolition wood; cascading use in the particleboard industry; the role of the wooden packaging industry in cascading; the reuse and recycling of furniture; and the role of biorefineries in the forestry and wood sector in Europe. A literature review, interviews with stakeholders, and feedback from the first and second stakeholder workshops held in June and November 2015 have been used to inform a detailed barrier analysis accompanying the case studies, focussing on both the provision and the utilisation of wood.

The sustainable technical available supply of wood from forests in the EU28 was 720.6 Mm^3 in 2010. The current forest sector's capacity to supply additional wood (roundwood) to the wood sector is limited to about 150 Mm^3 per year. However, economic mobilisation and high softwood utilisation already cause market scarcity of wood in some regions. Cascading use of wood is therefore a relevant and important way forward to alleviate the pressure on forest wood supply and to meet increasing demand for material applications of wood. Of the total yearly amount of used wood in the EU (52.3 Mm^3), on average 36.4 Mm^3 is recovered by collection systems. Of this figure, 16.8 Mm^3 (32%) are used for material applications; 19.6 Mm^3 (37%) for energy; and 15.9 Mm^3 (30%) are still disposed without recovery[1]. The paper sector has a much higher recycling volume compared to other parts of the wood sector. Of the total yearly recovered waste paper volume in the EU (129.8 Mm^3) on average 125.9 Mm^3 (97%) is used in the paper industry and the remaining 3.9 Mm^3 (3%) for energy.

The quality and availability of collected waste wood is hindered by: contamination through the (past) application of preservatives, paints and glue; lack of source separation of demolition wood and post consumer wood from households; lack of legislation defining different wood waste classes; limited possibilities for full automatic detection and sorting of mixed wood waste fractions at reasonable costs; and limited commercial perspective to clean specific waste wood fractions such as window frames.

[1] In some countries the amounts of organic waste landfilled are still higher than allowed according to the Landfill Directive.

Multistage cascading use of wood is bound by the technical possibilities and economic considerations available at the present time to overcome these issues.

Cascading on the basis of recovered wood use in the wood panel and board-sector so far is limited to particleboard production. For the production of other types of panels (such as fibreboard, fresh roundwood and clean residues are generally needed. Used sawn wood (especially from packaging) forms an excellent input for particleboard production, as it is generally clean and dry. Used panels have a limited potential for further utilisation (due to contaminants), while the production of panels has increased substantially over the past decades. Research and development to increase the utilisation of used panels other than particleboard is important to expand the possibilities of multistage cascading.

The total provision of wood processing residues is 178.7 Mm^3 (2010) and consists of three main assortments. Sawmill residues (82.3 Mm^3) are an untreated and clean wood resource that can be used materially in the pulp and panel industry. Black liquor (59.6 Mm^3) is currently used energetically in the pulp and paper industry and to regain chemical substances as part of a circular production process, but can also be used as a resource for new bio-based products in bio-refineries. Other residues (36.8 Mm^3) occur mainly in the finished products production processing sector and are of varying quality, depending on the combination with other substances (materials). The total volume of residues is linked to the overall use of wood products, because they occur within the production process.

Multistage cascading use of any product inherently has to deal with barriers caused by the interrelation between material flows of product A to product B. The producer of product A has to take into account the next cascading use in the design of product A, but does not participate in the benefits of the producer of product B. Producer B has limited or no influence on the activities of producer A, particularly if this producer is active in another sector. Furthermore it is observed that the number of widespread multistage cascades in the wood sector is limited to paper recycling and particleboard production, which next to technical barriers can also be ascribed to the relatively low price of fresh wood versus the costs associated with collection, sorting, cleaning and application of used wood. The question is whether increased research and development (R&D) efforts could solve associated technical and logistical challenges to a degree that cost effective solutions can be realised.

Governance barriers were identified that hinder cascading use of wood. There is no EU wide obligation for the source separation of recyclable wood materials such as exists for glass, plastics, metals and paper. Regulations governing the maximum allowable contaminants in particleboard differ between countries, with Germany and Austria following strict national regulations, whilst other countries follow the European Panel Federation (EPF) standards. The waste status of recovered wood fractions limits trade and application in products. However, introduction of End-of-Waste criteria should be carefully designed as loss of the waste status also implies that the waste hierarchy does not need to be followed (and which favours material use over disposal, composting or recovery for energy).

There is generally a lack of an integrated approach towards energy and material application of biomass. Energy and material uses of biomass tend to be dealt with separately in policy-making, resulting in a lack of integrated assessments on which to determine the various options for biomass use. The possible impacts of public support for bioenergy production on cascading use was investigated with specific focus on recovered wood used by the particleboard industry, as this sector perceives most competition with the bioenergy sector. The large differences between the types of incentives with the EU and the amount of support (e.g. the level of feed-in tariffs, grants, etc.) make it impossible to quantify exactly the impacts of bioenergy

incentives on the material sector. Analysis of wood paying capabilities[2] of supported bioenergy plant types in the Netherlands, United Kingdom, and Germany showed that incentive schemes that are aligned to support bioenergy plants using fresh wood chips and pellets, have a wood paying capability higher than for material use in the particleboard industry. This causes competition in some cases where these plants are allowed to use (clean) recovered wood. All investigated incentive schemes in this study allow the use of industrial residues, which cause direct competition with the material sector. The situation is not uniform across wood fractions. For example, competition from the bioenergy sector for pulpwood is likely only when pulpwood is available nearby to the bioenergy plant. Given the roundwood prices throughout Europe, in general competition of the incentivised bioenergy sector with the material sectors using roundwood is not likely.

There is circumstantial evidence that subsidies for energy wood consumption have caused a significant capacity expansion in the EU, which has in turn caused a significant increase in the demand for energy biomass. This has resulted in higher prices for wood assortments that can be used for energy, such as small diameter roundwood, residues, and post-consumer wood. The effect on the wood industry capacity depends on the overall growth development. In the globalisation phase (1991-2009) of the wood sector, with very high growth rates, increased competition may have caused lower profit rates but no visible effects on production and capacity. This has changed since the financial crisis (2009) as well as in the recovery phase (2010-present), which may be followed by a longer growth phase but at lower rates. In such an economic environment the negative effects of an unequal playing field of resource prices will most likely affect the wood industry much more significantly than in the past phase of strong growth.

Measures for a wider application of cascading use of wood

The wood sector has a particular form that means not all of the existing initiatives and measures developed in other sectors to improve resource efficiency can be applied easily to help improve cascading use. The wood sector utilises a range of different source materials from different locations and within multiple different sub-sectors, such as sawmills, recycling facilities, product manufacturing centres, etc. Many of the successes seen in recycled materials to date (such as paper, glass and metal) can partly be explained by the fact the discarded product is transformed (usually) into a similar product within the same sector or even industry. This is generally not the case for wood based products.

The potential to cascade wood takes place within two broad areas within the wood flow, in relation to residues produced in the processing of wood, and in relation to the waste generated following the use or consumption of a wood based product. Each stage has different requirements to promote cascading. In this study the measures to improve cascading have tended to focus on those relating to post consumer wood (i.e. the waste streams), in line with the broader circular economy and resource efficiency initiatives. It should be noted however that the waste wood stream represents a proportionately much smaller volume of wood (52.3 Mm^3 in total with on average 36.4 Mm^3 recovered) with potential for cascading than that of the much larger residues stream (~178.7 Mm^3) (2010 figures). The current diversion of residues towards energy use is something that can be addressed through improved harmonisation of policy in this area, and through the integration of residual wood fractions into products. Both waste wood and residues need to be tackled together to improve cascading use of wood as a whole.

[2] The maximum wood price a plant can pay if it makes no margin.

Of the measures identified in this study, many are being developed or are in place currently in different parts of the EU, although not always for woody biomass. Measures that aim to improve the recoverability of wood, such as separate collection, standardisation of waste wood assortments, labelling of recovered wood products and improved scanning and separation technologies and techniques could benefit both wood and non-wood waste utilisation in the EU. There are relatively limited risks in implementing such approaches, particularly as many are already adopted for other waste streams. Some measures however require more research to understand their potential impacts and applicability in a range of contexts. For example, legal requirements for recycling wood or wood containing products, changes in the legal status of waste wood fractions, and quality standards could all have impacts on producers, consumers and the market. One measure that could benefit the cascading use of wood and broader resource efficiency objectives is that of improved harmonisation between energy and material use in policy. In the EU efforts have been made to move attention towards bioenergy feedstocks that are genuine and unavoidable wastes, rather than processing residues or primary biomass that could have other uses and markets. Care would therefore need to be taken to follow this same logic within any efforts to promote the resource efficient use of wood for material purposes (i.e. cascading) and not lead to further conflicts within the current policy framework.

Implementing any of the measures set out in this report in isolation would likely not be sufficient to lead to an increase in cascading use in practice, with a variety of measures needed in any given situation. For example, banning the landfilling of wood or improving the collection and separation of wood waste helps primarily to increase the availability of wood that could be recycled or used in a subsequent cascade. Whether or not that wood *will* get used depends on a variety of other related factors, such as whether there is a market for the recovered wood; whether it is cost effective to utilise (in relation to removing contaminants, moisture etc.); and its proximity to where it can be utilised (transport distances). The individual measures potentially improve the conditions for cascading but for it to become more widespread multiple issues would need to be addressed simultaneously.

Understanding which issues to address and which measures to apply and in which situations is particularly challenging because:

- The precise mix of measures will vary depending on the context and the Member State or sector in which they are implemented;
- Each barrier to cascading may have an ideal solution in a given context, or may have multiple solutions that could achieve similar outcomes;
- The desirability of the different options will vary between Member States and sectors; and
- Both market and policy drivers have a key role to play in whether or not woody biomass is cascaded and the involvement of key stakeholders in developing potential measures is critical.

At the EU level the following specific actions would be beneficial to improve the resource efficient use of wood and help to overcome barriers to the cascading use of wood:

- The development of an EU standard for the classification of wood waste assortments to provide harmonisation between Member State approaches, improve understanding or potential uses and trade;

- To make explicit reference to wood under the definition of organic and biodegradable wastes in relation to the Circular Economy package;
- To develop a platform through which to share best practice on the cascading use of wood, particularly where existing barriers have been overcome in specific situations. This could be linked to existing initiatives such as the European Innovation Partnership (EIP) and existing forums, such as the Raw Materials Supply Group (RMSG);
- To improve the data around wood/wood waste use and flows through improved reporting and traceability of wood assortments;
- Enable and support research activities to overcome specific technical barriers to cascading use;
- To ensure that the material and resource efficient use of wood is a central element in the potential development of the Bioeconomy strategy as foreseen to be revised in relation to the Circular Economy package;
- To undertake a scoping exercise to assess the need for public policy intervention in the promotion of woody biomass utilisation for material purposes, identifying the specific intervention logic and potential impacts; and
- To develop improved climate and energy policy that better recognises the carbon benefits of material applications of wood and balances this with the decarbonisation of Europe's energy supplies.

Recommendations from the study

The following specific recommendations are made based on the findings of this study:

- Data and information on the source and destination of wood resources in the EU is lacking. The development of **improved tracking and reporting tools** with central information collection could help to improve understanding of the potential to and the benefits from increased cascading. This study provides a methodology to calculate the status of cascading use, including provision and utilisation of wood of relevant semi-finished products, which is a start to the development of these tools.
- The approach to definitions and categorisation of waste wood assortments varies considerably across the EU. An **EU standardisation of wood waste assortments** would help to improve the sharing and trade in wood resources across the EU, improve understanding of potential end-uses and lead to new market developments. Existing standards should be reviewed and a consolidated standard produced at the EU level, in consultation with Member States and relevant industries.
- Improving the cascading and resource efficient use of wood requires interventions all throughout the wood flow. It is recommended that **a 'tool kit' of measures and activities to promote the cascading** and more resource efficient use of wood be developed for use with Member States and industry. In order to develop this tool kit, the measures proposed should be investigated in more detail, considering the likely impacts in a range of different Member States, which was beyond the scope of this study.
- Cascading use is one tool to help promote the more resource efficient use of wood. This study has necessarily focussed on a specific definition of cascading. However, **cascading should be communicated in conjunction with other measures** to improve resource efficiency within the wood and wood using sectors, such as prevention, re-use as well as other approaches to optimising processes and product design as well as the optimisation of specific material streams, such as industrial residues.

- Understanding better the links between renewable energy policy implementation and the impacts on material markets requires further investigation. It is clear however that there is some interplay and **more could be done to harmonise energy and material policy**. Addressing this issue should be the focus of efforts when developing the post 2020 energy and climate initiatives, and when considering the potential changes to the Bioeconomy strategy in relation to the recent Circular Economy package.
- The different wood volumes arising at different stages of the wood flow deserve special mention. Whilst improvements to the recovery and utilisation of post consumer wood (waste wood) are necessary to meet circular economy and resource efficiency objectives, industrial residues present a far greater volume potential for cascading. Despite this, the intervention logic to prompt EU action in this area tends to arise as a response to the competing and incentivised utilisation of such material for energy purposes, rather than the specific promotion of material use in isolation. The potential to improve the availability of residues for material use should be considered in light of the significant volume of residues.
- Wood is a product with a strong regional anchoring therefore any support for the utilisation of wood could be considered as a contribution to regional development. The **different options to utilise wood should consider the most appropriate use of wood in each context**. In some cases energy use may be the most efficient use of wood, due to supply volumes, or lack of suitability for material use.
- Some wood fractions are not suitable currently for material applications. For example, recycled clean sawn wood is very suitable for material utilisation, but cascading used panels (e.g. particle board, plywood, MDF, OSB) or impregnated sawn wood is technically difficult. **The suitability of each wood fraction for material and energy application should be considered in the context of harmonising energy and material policy**.
- The wood sector and the potential to influence cascading are diverse. **Research** should be commissioned in certain strategic areas in order to improve understanding further and develop new initiatives. These areas should include: *in situ* sorting and separation techniques; supply chain development between disparate actors; technological developments in utilising hardwood streams more effectively; scanning and separation technologies; product labelling and tracing; amongst others.
- Attention should be paid to improving the **quality of statistical data in the following ways:**
  - Regarding waste wood and recycling data on post-consumer wood date back to a large extent to the COST action E31 from 2010. Current data on recycling of wooden packaging waste is not considered robust; moreover, hardly any statistical information is available on "preparing for reuse" of wooden packaging materials and should be improved in order to better inform resource efficiency ambitions, such as proposed under the Circular Economy package.
  - Existing data quality of energy use is very poor. A huge progress is the Joint Wood Energy Enquiry (JWEE) of the UNECE. Such activities should be supported.
  - The knowledge base of wood use in end-user markets is very poor. End-user markets consist of a broad variety of products and material mixtures, which makes this research more complex. The quantification of end-user markets should be promoted as well as the material proportion of such products is needed to monitor cascading use.

- Research activities are suggested to further **improve the understanding of wood flows** in Europe. For instance, according to wood flow analysis just over one quarter of the inflow material is potentially available as waste wood. Therefore, it would be important to analyse the destination of the other two thirds and whether this is used or sequestered in products. Such information could also be valuable for research on carbon sequestration in harvested wood products.
- To enable cascading measures to be effective requires a series of **general framework conditions to be in place to help support the actors and initiatives involved.** These should be developed with cross border partnerships involved, to help the functioning of the internal market. To reduce the burden on operators and the EU institutions, efforts in this area should be streamlined with those already in place (or development) for the circular and bioeconomy initiatives. Parallel activities in the energy sector would also be worthwhile in order to try and harmonise implementation approaches, as well as the policies that drive activity in this area.
- Finally, any promotion of wood must be done within the limits of sustainable harvesting of primary biomass and with a suitable reporting and monitoring system in place.

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