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Barriers and enablers of wood cascading

Lessons for a circular bioeconomy

RESULTS IN BRIEF

Are you struggling to move biobased industry towards the circular economy? Longstanding research on wood cascading (i.e. maintenance and reprocessing of biomass at its highest material value before converting it to bioenergy) has identified a variety of factors to enable a more efficient, circular use of forest-based products in Europe. We provide an overview of these factors and their interactions.

Based on our review, two of the most critical barriers for wood cascading are:

- **Competition between energy and material uses** of waste wood in policy, market and infrastructure
- Missing information on and low **quality of waste wood**, including pollutant content

Action recommendations for policy and business:

- ▶ Redesign production processes to deal with contamination and increase quality
- ▶ Coordinate energy and waste policies across departments
- ▶ Advance reporting standards about material composition of bioproducts
- ▶ Explore the best types of involvement, awareness raising, communications and policies



WHAT CAN WE LEARN FROM WOOD CASCADING?

Whether it is for energy production, construction or disposables, more and more sectors are shifting to biobased materials. This increases pressure on forests and other resource bases leading to **environmental degradation and scarcity**.

To enable the long-term feasibility of a bio-based economy, **resource efficient, circular strategies are needed**. Recently, many actors unite under the umbrella ‘circular bioeconomy’, but knowledge on its barriers and enablers is only emerging and not yet comprehensive.

In the forest-based sector, **wood cascading is a longstanding approach** that shares the goal of using bioresources efficiently. Cascading describes the sequential and co-

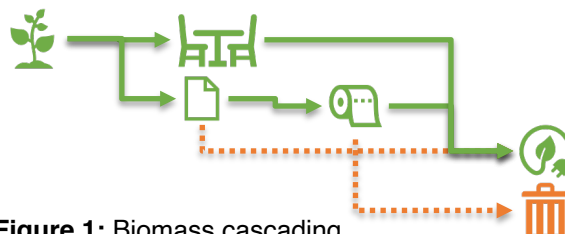


Figure 1: Biomass cascading.

producing use of biomass to leverage as much value as possible (Fig. 1, Odegard et al., 2012). This includes e.g. particleboards, paper recycling and eventually bioenergy.

Research has revealed multiple factors hindering and enabling cascading in the wood sector (Figure 2). This knowledge can help policymakers and business leaders to **design effective policies to promote the circular economy in biobased sectors**.

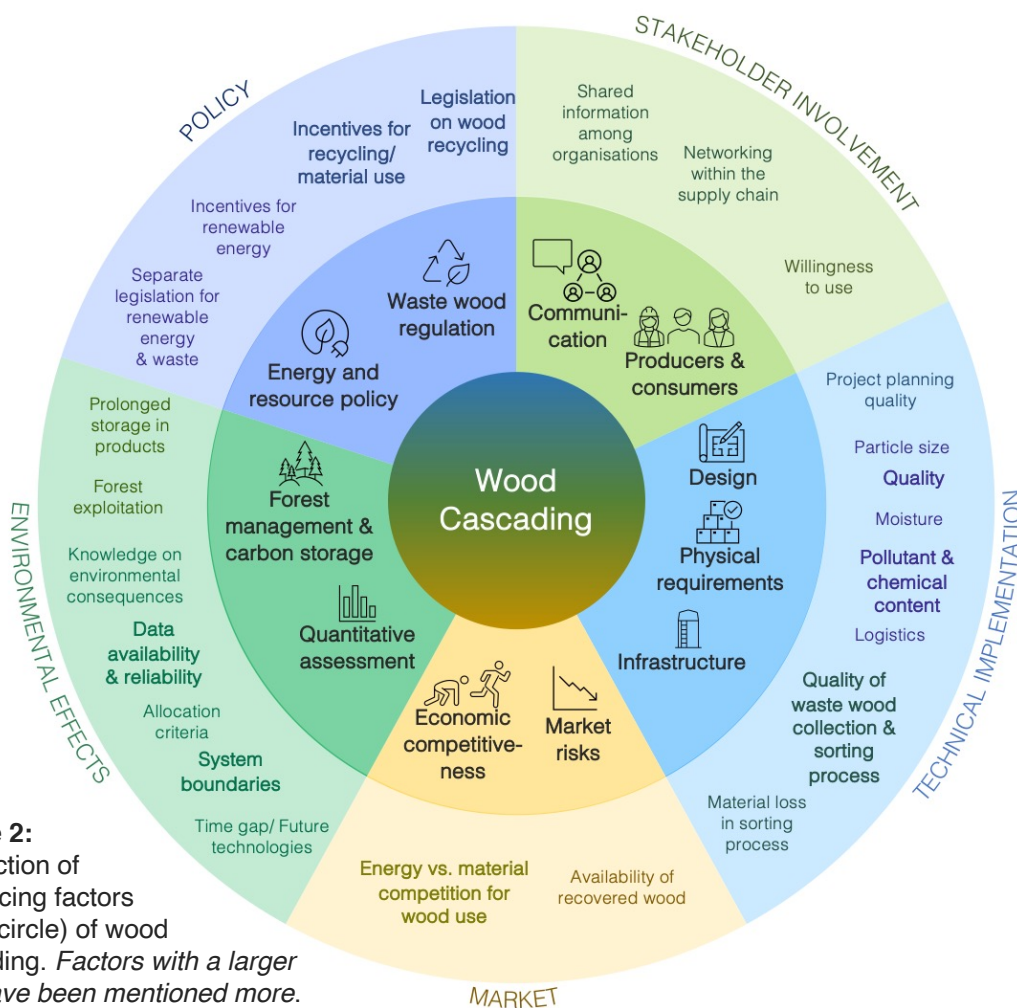


Figure 2: A selection of influencing factors (outer circle) of wood cascading. *Factors with a larger font have been mentioned more.*



WHICH FACTORS INFLUENCE WOOD CASCADING?

Our review shows a full spectrum of factors that influence the success of wood cascading (Figure 2). Some, such as incentives for recycling, enable cascading; others, such as moisture, hinder cascading implementation. Technically, all of these barriers and enablers are interdependent and need to be addressed for an effective implementation (Figure 3). Two factors appear particularly prominent. These include:

- The trade-off between using wood residues for **bioenergy production vs. prioritising material recycling**. This competition does not only play out on the market, but it manifests in energy/recycling infrastructure and conflicting energy and waste policy. It is further complicated by a lack of conclusive environmental assessments.
- The low quality of waste wood including **pollution with additives**, and a **lack of documentation on such pollution** at the end of life can hinder its usability for reprocessing. A lack of suitable treatment infrastructure to increase quality aggravates the effect.

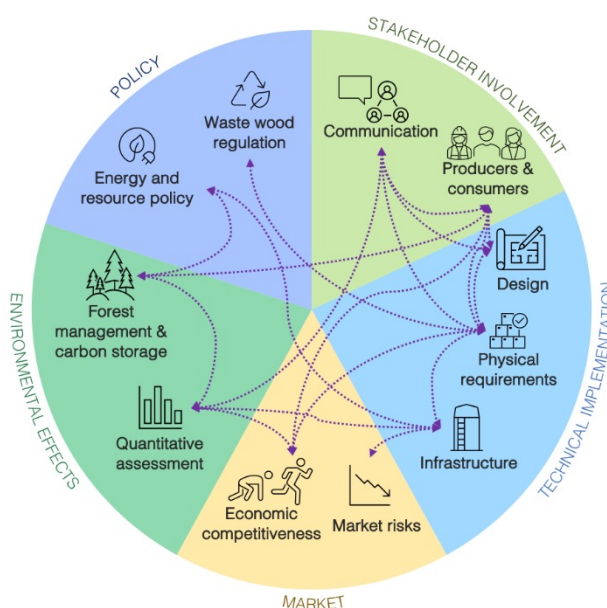


Figure 3: Interdependencies among categories retrieved from published research on cascading

HOW WE IDENTIFIED BARRIERS AND ENABLERS

To provide an overview of barriers and enablers, we **reviewed 41 articles on wood cascading** published in peer-reviewed journals over the past 25 years.

From these publications, we identified 55 factors influencing wood cascading implementation. These were grouped into categories for clarity (Figure 2, for a full overview please read our publication).

The publications also contained statements about **interdependencies between factors** which are summarised in Figure 3.

Special attention was paid to factors that were highlighted in more than five publications, as well as those related to many other factors.

LIMITATIONS

The identified barriers and enablers are promising starting points for more effective policymaking for the circular bioeconomy.

Still, the factors presented here are **based on the wood sector only**, which might not reflect all the specific challenges faced in other bioeconomy sectors.

Also, **cascading represents only part of the full spectrum** of circular strategies.



WHAT CAN YOU DO? – OUR RECOMMENDATIONS

POLICY MAKERS

FACE THE QUALITY CHALLENGE

Technical barriers related to the material condition of residues such as contamination with additives, decomposition, moisture and small particle sizes present major barriers for further material uses of waste wood. Thus, a circular bioeconomy may face very different challenges with reuse and remanufacturing than mineral sectors. Starting points to remove the barrier include:

- ▶ **Invest in sorting and treatment plants** that increase the quality of bioresidues
- ▶ **Incentivise cascading innovation** that leverages special conditions such as small particle size
- ▶ **Require thorough reporting** on material composition from producers and processors to enable assessment of the best alternative in terms of environment

ALIGN ENERGY & WASTE POLICY

Wood residue should not be wasted on bioenergy production as long as it is still fit for reprocessing to leverage the highest value possible. Unfortunately, renewable energy policy and waste policy are not always aligned on this. To enable systemic change towards a circular bioeconomy:

- ▶ Coordinate across departments to **establish a common policy framework** for energy and waste policy
- ▶ **Remove subsidies for bioenergy** production from biomass that is fit for higher value reprocessing

SUPPORT CASCADING BUSINESS

The interdependency of factors makes it hard to establish circular practices in bio-based sectors. Thus, while removing barriers is necessary, active support is also required:

- ▶ **Incentivise material uses of biowaste** proactively

BUSINESS LEADERS

INVESTIGATE SOFT INFRASTRUCTURE

Soft infrastructures like stakeholder involvement and the right policies are deemed crucial by a lot of technical analysis. But **the types of involvement, awareness raising, communications and policies that are needed** has yet to be thoroughly investigated.

DESIGN FOR CASCADING

Additives, moisture and small particle sizes at the end of life hinder the cascading of biobased materials. If considered right from the start, you can prevent unnecessary waste production:

- ▶ **Avoid additives** unless absolutely necessary, e.g. check the needs of your customers
- ▶ **Turn waste into value** and check if you can integrate residues as a resource in your production

PREPARE FOR THE END OF LIFE

A lack of information on the quantity, quality and relevant properties of bioproducts and waste complicates recycling as well as the assessment of sustainability impacts of cascading.

- ▶ Collaborate with other businesses to advance **cross-sectoral reporting standards** including common system boundaries
- ▶ Take responsibility and **share adequate information** on material composition and transformations undertaken with waste processors and academia.



FURTHER INFORMATION & SOURCES

The full study “**Transforming the bio-based sector towards a circular economy - What can we learn from wood cascading?**” (2018) by M. Jarre, A. Petit-Boix, C. Priefer, R. Meyer & S. Leipold can be accessed here: <https://doi.org/10.1016/j.forpol.2019.01.017>

Introduction to Biomass Cascading:

Odegard et al. (2012). Cascading of biomass: 13 solutions for a sustainable bio-based economy. https://cedelft.eu/wp-content/uploads/sites/2/2021/04/CE_Delft_2665_Cascading_of_Biomass_def.pdf

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The **Circular Economy Series** presents research results of the research group “**Circulus - Opportunities and challenges of transition to a sustainable circular bio-economy**”. The researchers are developing a comprehensive understanding of possible pathways to a circular economy in Germany and Europe. To this end, they combine perspectives from the social, environmental and engineering sciences to analyse the ecological and socio-economic consequences of the circular economy in various sectors.

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