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

GEOGRAPHICAL FOCUS:

South Tyrol

THEMATIC FOCUS A:

Ash utilisation (Recycling)

1. Facts on the potential

By 2050 the potential energy production from biomass will be, worldwide, in the range of 100 to 300 Exajoule (2300 to 7100 Million Tonnes of Oil Equivalent) per year, compared to the current 50 Exajoule1[1]. The process of energy production by combustion of biomass has environmental advantages; however, it also generates large amounts of ashes. This can become an environmental problem if Ashes are not properly managed[2].

Around **3530 tons of ash** per year are produced in South Tyrol[3]. These include bottom ash[4] (boiler ash) and fly[5] ash (gasifier and filter ash). The total amount of ash is the result of the burning of **527 000 solid cubic metres of wood** in South Tyrol's District Heating Plants (DHP)[6].

This amount represents ~**54%** of the annual wood used in South Tyrol for **energy production**. **46%** is burned in private heating systems, which is **not collected centrally**.

Current utilisation of ash in South Tyrol:

- **Compost:** a limited amount of ash is added to compost
- **Concrete:** ash is used in the production of concrete
- **Deposition:** ash is deposited as waste material. The EU and Italian regulation recommend this just as an "extrema ratio".

Further uses of ash allowed[7] in Italy:

- Production of fertilisers[8]

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1 Estimation of the International Energy Agency. Agrela et al., 2019: 25.
2 Exajoule = 10^{18} joules
3 2018, estimation based on the Expert Interview
4 Biomass bottom ash (BBA) includes the coarse fraction and is formed by the total or partially burnt material. (Agrela et al., 2019: 29)
5 Biomass fly ashes (BFA) are the particles separated from the stream of gases outside the combustion chamber, so they are the finest fraction of the ashes. (Agrela et al., 2019: 30)
6 Stauder, 2014:18
7 D.M. 186/2006 (that modifies 05.02.1998, n. 22) "Recupero di materia con procedura semplificata"
8 In compliance to the Italian Law n. 748, 19 October 1984 (Aial Energia, n.d.) Agrela et al., 2019: 30

2. Drivers and Barriers

2.1 Drivers

CATEGORY	WHAT BENEFITS WOULD THERE BE IN UTILISING ASH?
Environmental	• Landfilling of the increasing amount of ash is not sustainable in the long run, alternative use can contribute in solving this. • Recirculation of removed nutrients (in case of use as compost or fertilizer).
Economic	• Cut or reduction of the cost currently paid by the district heating plant for disposing the ash (€120-200 per ton). The latter will likely be rising, in consistence with the increasing production of ash.
CATEGORY	**WHAT ASSET CAN SOUTH TYROL BOAST?**
Supply Chain	• The ash produced by South Tyrol's "public" DHPs is collected by one company. The raw material is all stored in one place.
Organisational	• In South Tyrol most part of district heating plants are connected within the "Südtiroler Energieverband".

2.2 Barriers

CATEGORY	WHY IS ASH POTENTIAL CURRENTLY NOT FULLY EXPLOITED IN SOUTH TYROL?
Economic	• The separation of individual ingredients in ash is not perceived as profitable
Institutional	• Legislative limitations. The European Community classifies ashes from biomass as **non-hazardous industrial waste**[9]. Therefore, the procedures for its use are not as simple as if it were a by-product[10]. Given its non-hazardous feature simplified procedure for some specific uses are foreseen. Specifically, for the production of: › cement mixes, use in cement factories or in the brick industry (code 13.2); › quality compost (code 16.1); › fertilisers in compliance with Law No 748 of 19 October 1984 (code 18.1). **Most relevant regulation on the topic:** › *European Commission waste material classification*[11] of 2000, codifies waste products; › *European waste framework directive of*[12] 2008, defines by-products and sets the basic concepts and definitions related to waste management; › *Italian Decreto Legislativo 152/2006*, art. 184, classifies ash as "special non hazardeus waste material"; › Italian Decreto Ministeriale 186/2006 on "Recupero di materia con procedura semplificata"[13], specifies the condition for the simplified procedure. › South Tyrol, Provincial Law n. 4, 26th May 2006
Technological & Informational	• Techniques to filtering out harmful substances from ash exist[14], but are not yet widespread
Supply Chain	• The quality of ash collected from South Tyrolean DHP is very heterogeneous. The complexity of Trace Elements presence in biomass is a result of influencing factors such as plant species, location and environmental conditions of growth[15]. This represents the biggest obstacle to the recycling of ashes in South Tyrol. • Dispersion of potential: Almost half of wood is burned in private households or businesses, which dispose of the ash in a decentered way. This ash is not accessible to date.

9 Agrela et al., 2019: 30

10 According to the European Waste Framework Directive, by-product is a production residue that fulfils legal considerations (certainty of further use, direct use, directly result from an industrial process, fulfil quality, environmental and health-protection requirements) and is not deliberately produced. (Silva et al., 2019: 114)

11 European Commission Decision 2000/532/CE, 3rd May 2000

12 Directive 2008/98/EC of the European parliament and of the Council of 19 November 2008 on waste and repealing certain directives. Off. J. Eur. Communities L 312/3, 22 November 2008.

13 The latter modifies the "decreto ministeriale 05.02.1998, n. 22")

14 (Voshell et al., 2018)

15 (Voshell et al., 2018: 483)

3. Hints for the future

Future perspectives:

- **Geopolymers production**. Concrete is the second most used material in the world and its production is not sustainable in the long run given it is produced with non-renewable materials. Geopolymers can substitute cement and be produced using ashes and other industrial by-products[16].
  In fact, The ashes from combustion in power plants contains heavy.
  It has been scientifically proven that geopolymers can effectively solidify or stabilise heavy metal ions[17].

- **Classification as "end of waste" material**. The European Waste Framework directive introduced the concept of end-of waste by setting out conditions[18] bwhereby substances which meet the waste definition can achieve a non-waste status, after undergoing a recovery operation such as recycling. This regulation also determines limits for pollution elements. Material could be proposed for reaching this status also by Member states.[19] This could potentially open new opportunities for the use of ashes form biomass.

Administrative & political measures to change trend:

What can the public administration do to overcome the barriers to a Circular Economy?
- Quality of ash: provide an economic incentive to District Heating Plants to produce homogenous ash.
- Innovation and research: subsidise research targeting the exploration of new materials based on ash.

Sources

Agrela F, Cabrera M, Morales MM, et al. (2019) Biomass fly ash and biomass bottom ash. In: New Trends in Eco-Efficient and Recycled Concrete. Elsevier, pp. 23–58. DOI: 10.1016/B978-0-08-102480-5.00002-6.

Aial Energia (n.d.). Available at: http://www.aielenergia.it/.

Ghisellini P, Cialani C and Ulgiati S (2016) A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. Journal of Cleaner Production 114: 11–32. DOI: 10.1016/j.jclepro.2015.09.007.

Näyhä A (2019) Transition in the Finnish forest-based sector: Company perspectives on the bioeconomy, circular economy and sustainability. Journal of Cleaner Production 209: 1294–1306. DOI: 10.1016/j.jclepro.2018.10.260.

Silva FC, Cruz NC, Tarelho LAC, et al. (2019) Use of biomass ash-based materials as soil fertilisers: Critical review of the existing regulatory framework. Journal of Cleaner Production 214: 112–124. DOI: 10.1016/j.jclepro.2018.12.268.

Voshell S, Mäkelä M and Dahl O (2018) A review of biomass ash properties towards treatment and recycling. Renewable and Sustainable Energy Reviews 96: 479–486. DOI: 10.1016/j.rser.2018.07.025.

16 https://www.youtube.com/watch?v=oq_he4a51cY

17 (Agrela et al., 2019: 49)

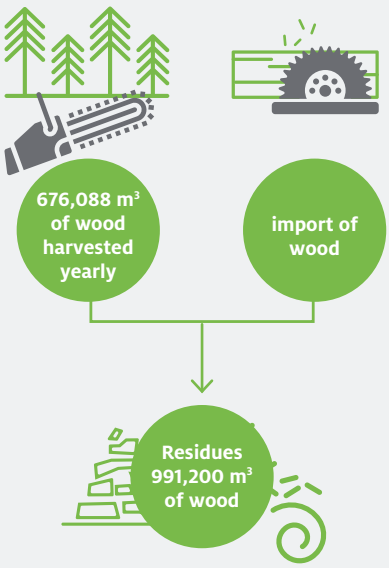
18 The substance or object is commonly used for specific purposes, A market or demand exists for such a substance or object,
The substance or object fulfils the technical requirements for the specific purpose and meets the existing legislation and standards applicable to products;
The use of the substance or object will not lead to overall adverse environmental or human-health impacts.

19 (Silva et al., 2019: 114)

THEMATIC FOCUS B:

Innovation to increase efficiency in the wood value chain: reducing residues (reduce) and increasing cascading (recycling)

1. Facts on the Potential



In South Tyrol, residues produced in forests, sawmills and the wood from forest thinning are principally brought to district heating plants (DHPs) to be used as biomass for energy production.
On average, **676,088 cubic metres of wood** are harvested in South Tyrol each year.
The residues of harvesting and processing local and imported wood (timber chips and branches, bark, firewood, old wood, sawdust, briquettes and wood processing by-products) amounts to **991,200 cubic metres**.[20]
This represents a potential. According to the tenets of circular economy, "implementing the energy conversion of wood shall be prioritised only when no further material use is possible" (Jarre et al., 2019: 6).

What are the option available?

1. "Reducing" residues produced in the sawmills.
2. Introducing a "cascading" (recycling) approach, which requires inserting additional steps in the wood processing before the conversion into energy.

To date, good examples of residue reduction/cascading are limited.
Further research and innovation can change this picture.

Best Practice Example

The Nordpan Rubner Case Study

The lumber company Nordpan Rubner has successfully adopted an innovative sawing and manufacturing techniques[21] that permit the use of approximately 40% of the log[22]. This process has been developed through 10 years of privately-funded research.

2. Drivers and Barriers

2.1 Drivers

CATEGORY	WHAT BENEFITS WOULD THERE BE IN REDUCING RESIDUES OR IMPROVING THE CASCADING USE OF RESIDUES?
Environmental	• "Closing the loop" and lower waste according to the circular economy principles by exploiting all of the material's utility and value, and storing CO2 longer
Economic	• Increase of economic profitability due to the reduced loss of material; • Increase in productivity, given the exploitation of the material value at all stages.
Social	• Increase of the regional value added, by increasing the number of processing steps that are taking place in the region
Technological & Informational	• Further use of a well-developed innovation support system in South Tyrol

20 Authors' elaboration based on (Stauder, 2014)
21 https://www.youtube.com/watch?v=QK9OLoLjTEs&feature=youtu.be
22 Estimation based on expert interview

2.2 Barriers

CATEGORY	WHY IS REDUCING RESIDUES OR IMPROVING THE CASCADING USE CURRENTLY NOT IMPLEMENTED?
Economic	• Existing incentives for woodchips for renewable energy use • Economic profitability of adopting cascading is not fully understood • Low investment capacity of firms. This is especially true in the sawing process, given the small-scale structure[23] of these firms and the low added value of sawing activity when separated from the manufacturing one.
Social	• Perception of burning residues in the local District Heating Plants as the best option • Low awareness and interest in innovation and optimisation of the process
Institutional	• Incentives for woodchip for energy use, see: **Beschluss Nr. 359 vom 01.03.2010**, Art. 5, f: Festsetzung und Genehmigung der Zuschüsse für Heizanlagen mit fester Biomasse > 40kw und < 40kw.
Technological & Informational	• Lack of knowledge on how to use resides remuneratively.
Supply Chain	• Value chain mainly composed of small actors, difficult scale effects
Organisational	• Logistic: District Heating Plants are close and easy to reach • Entrance barrier to different products, it is professionally organised

3. Hints for the future

Administrative & political measures to change trends:

- Face the lack of economies of scale: organise a platform that collects residues from the whole Province to allow companies to buy from little farmers or old wood
- Create incentives for District Heating Plants that use wood not directly coming from forests to enhance use of cascading
- Strengthen laws such as "Legge 14/2006 Sussidi provinciali per l'innovazione e la ricerca", subsidise innovation that increases the cascading, reuse and recycling of wood

Sources

Ghisellini P, Cialani C and Ulgiati S (2016) A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. Journal of Cleaner Production 114: 11–32. DOI: 10.1016/j.jclepro.2015.09.007.

Jarre M, Petit-Boix A, Priefer C, et al. (2019) Transforming the bio-based sector towards a circular economy - What can we learn from wood cascading? Forest Policy and Economics. DOI: 10.1016/j.forpol.2019.01.017.

Näyhä A (2019) Transition in the Finnish forest-based sector: Company perspectives on the bioeconomy, circular economy and sustainability. Journal of Cleaner Production 209: 1294–1306. DOI: 10.1016/j.jclepro.2018.10.260.

Stauder M (2014) Holzströme in Südtirol 2012. Interreg South East Europe co-financed project, Foropa project Report, November. Available at: http://tis.bz.it/de/cluster/holz-technik/doc/pdf/doks-foropa/HolzstrmeinSdtirol2012_Endbericht_DE.pdf.

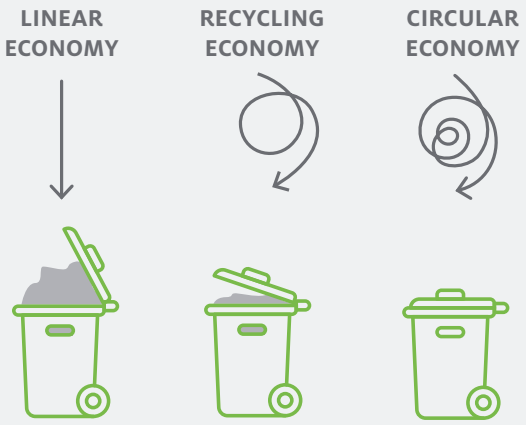
23 http://www.hk-cciaa.bz.it/it/servizi/registro-delle-imprese/imprese-e-prodotti/ricerca-codice-attivit%C3%Ao

The background: CirculAlps project

CirculAlps is a project co-funded by the European Union through the Alpine Region Preparatory Action Fund, within the framework of the European Union Strategy for the Alpine Region. CirculAlps aims at promoting a circular and bioeconomy throughout the Alpine timber-based value chain. CirculAlps project investigates the material flows and value chains of forestry and wood-based sectors of five remote Alpine areas in four Alpine countries: Austria, Germany, Italy and Slovenia. The five research areas differ in their size, but all have in common that their local economy is characterised by forestry and wood-based value networks. The project focuses on the residues of the current wood production chain given their potential for circular economy application.

What is a Circular Economy?

"A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times"[24]. Circular Economy mainly emerges from literature through the 3R principles: **Reduce, Reuse, Recycle**.
Reducing = utilising less input in the production.
Reusing = use again products and components for the same purpose for which they were conceived.
Recycling = any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes[25].



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