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State-of-the-art of waste wood supply chain in Germany and selected European countries

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ABSTRACT

According to the statistic office of the European Union (Eurostat), Germany is the main producer of waste wood in Europe followed by France, United Kingdom, Italy and Finland. Based on the characteristics of the waste wood, it can be classified in four (4) categories: A I, A II, A III and A IV. This paper focuses in the A I waste wood since is the only category able to be used directly for both material and energy purposes without a previously pre-treatment. Currently, most of this waste wood is used for direct energy production due to the previous government legislation that promoted its use directly in incineration facilities. However, the newest Renewable Energy Act (EEG 2017) may promote the cascade-use of A I waste wood prior to be intended for energy purposes. Nonetheless, the government incentives to the energy sector is not the only bottleneck that the use of A I waste wood as raw material in the wood-based industry has to overcome. The peak availability, collection logistics (collection centers and transportation) and recycling facility location are some of the parameters that must be considered in order to design the "best" supply chain network for A I waste wood. This work presents a detailed description of the effect of the hierarchical strategic decision in the proper design of the waste wood supply chain. Additionally, the global picture of waste wood recycling in different European countries (UK, Italy and Finland) is briefly presented.

Contents

1. Introduction

According to the Federal Statistical Office (Umwelt Bundesamt, 2017), Germany produced 401 million tons of wastes in 2015, from which waste wood[1] accounts to 11.9 million tons (Sommerhuber et al., 2015; van Benthem et al., 2007). This waste wood is obtained from different sources such as wood packaging (21%), demolition and construction (26.7%), wood processing industry (14%), municipal

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[1] Waste Wood = Material before processing in recycling facility
Recycled Waste Wood = Material after processing in recycling facility.

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wastes (20.7%), import wood (9.7%) and others such as private households and railway construction (8%) (van Benthem et al., 2007). More than twenty years ago, wood wastes in Germany were used as energy source in incineration plants or merely, they were disposed in landfills. Nevertheless, the Germany government recognized that safe disposal was not enough and the resources had to be re-used by recycling. Waste avoidance had to be given the highest priority. Based on this statement, it was implemented an environmental policy that established the prerequisites for effective and environmental sound waste avoidance and recovery in the production stage (Federal Ministry for the Environment Nature Conservation Building and Nuclear Safety, 2017). Between 2013 and 2014, Germany re-used 34% of the waste wood in the wood-based industry to produce particleboards (Meinlschmidt et al., 2015). In comparable countries, such as United Kingdom, this share accounts to 53%, whereas it reaches 95% in Italy, as can be demonstrated in Table 1.

The recycling rate of waste wood in Germany is still low due to different legal resolutions that were adopted with the goal of controlling the use of contaminated waste wood in different applications. In this sense, the Ordinance on the Management of Waste Wood (Altholzverordnung) laid down requirements for the recycling, energy recovery and disposal (Protection Federal Ministry of Justice and Consumer, 2002). In this Ordinance, it was established the quality requirements of the waste wood to either energy recovery, re-use or recycling. Four different categories were used to categorize the recycled waste wood based on the presence of preservatives or other chemical substances (see Table 2).

Despite the strict control of recycled waste wood, some non-wooden materials can also be found in recycled wood chips. As a consequence, the sorting is not 100% and remaining residues, such as metals and plastic, should be considered for a further treatment. Most of the recycled waste wood derives from the packaging and construction & demolition sectors are classified in the categories A II and A III (see Table 3). A I waste wood accounts to 17% of the total production of recycled waste wood in Germany (van Benthem et al., 2007). Due to the low availability of "clean" waste wood, 20% of the recycled waste wood (mainly, A I and A II) is used to produce wood-based products (e.g. particleboards) and the remaining 80% (A III and A IV) is used to produce energy in incineration facilities (Sommerhuber et al., 2015). Another important factor that encourage the use of the waste wood for energy production is the sale price. Whereas the sale price of the A I waste wood for energy purposes ranges between 70 and 80 € per ton, the sale price of A I waste wood for particleboard production is approximately 60 € per ton (EUWID Europäischer Wirtschaftsdienst GmbH, 2017). Based on this outlook, the recycling companies are more attracted on selling the A I waste wood to the incineration facilities because of the higher revenues. Some incineration facilities in Germany are also using the contaminated waste wood (mainly, A II and A III) for energy production due to the low cost (40–50 € per ton) (Sommerhuber et al., 2015). In this sense, due to the high availability and low cost of contaminated waste wood, most companies prefer to burn these residues to produce energy instead re-using, cascading and improving their added-value.

In order to improve the added-value of the recycled waste wood, the Waste Framework Directive (2008/98/EC) (European Parliament, 2008) presents a guideline of basic concepts and definitions related to the waste management. It explains the concept end-of-waste criteria that it is used as a guideline to determine when a waste cease to be a waste and become a secondary raw material. The waste hierarchy to fulfill the end-of-waste criteria is presented as follows (see Fig. 1).

Table 2
Recycled waste wood categories in Germany.

Category	Description	Applications
A I	Untreated or only mechanical treated wood	Chips and Shavings to produce wood-based materials, synthesis gas and activated carbon production (possible energy)
A II	Glued or painted wood (No halogen-organic compounds or preservatives)	Chips and Shavings to produce wood-based materials, synthesis gas and activated carbon production (possible energy)
A III	Wood containing halogen-organic compounds; no preservatives	It can be used as material if the varnishes and coatings are removed
A IV	Contaminated Wood, including halogen-organic compounds No PCB	Energy use in large combustion facilities
Polychlorinated biphenyls (PCB)	PCB treated wood	Non-hazardous disposal

Table 3
Distribution of the recycled waste wood from the Ordinance categories.

Category	Percentage (%)
A I	17
A II	34.7
A III	31.4
A IV	16.7
PCB	0.1

Table 1
Use of wood and waste wood in the production of particleboards in European countries (Meinlschmidt et al., 2015).

	Share of Roundwood[a] (%)	Share of Industrial Waste Wood[b] (%)	Share of Recycled Waste Wood[c] (%)
Germany	20	46	34
France	41	37	22
Italy	0	5	95
Poland	38	47	15
Spain	31	41	28
Switzerland	20	45	35
UK	16	31	53

[a] Roundwood = timber that is left as small logs, not sawn into planks or chopped for fuel and used for furniture.
[b] Industrial Waste Wood = All wood used as by-products, residues and waste in the woodworking and processing industry.
[c] Recycled Waste Wood = Material after processing in recycling facility

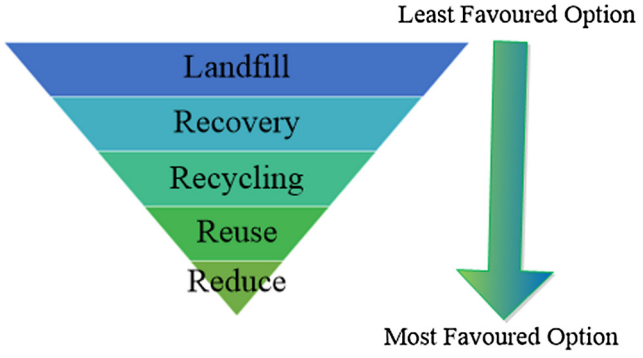

Fig. 1. Scheme of the European Waste Framework Directive.

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