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Assessment of the coherence of the Swiss waste wood management

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ABSTRACT

Waste wood recovery by thermal treatment with energy recovery or by recycling allows the substitution and conservation of primary resources. Swiss government notes the potential presence of tensions between policies which simultaneously encourage the cascade use of wood, the recycling or the energy recovery by thermal treatment of waste wood. The aim of the present research is to assess the coherence of waste wood management in Switzerland by a quantitative and qualitative approach. First, a material flow analysis allows to model the wood resources and waste wood metabolism over one century. The simulation results of various scenarios of waste wood management establish that the additional impacts of the immediate thermal treatment are less significant for the reduction of CO_2eq emissions but more significant for the energy production than its cascade treatments on Swiss territory. Secondly, a documentary analysis examines the determinants of the current waste wood treatments prevailing in Switzerland. Thus, the causes of the strong presence on Swiss territory of the sector of thermal treatment, the export of almost half of waste wood generated and the sub-exploitation of Swiss forest act as barriers or drivers that result in introducing a crowding-out effect where no amount of waste wood is available for recycling in Switzerland. The comparison of the results of the two approaches leads to the conclusion that the current waste wood management is coherent in relation to the various goals of the Swiss federal policies but the waste wood potential for energy production is not fully exploited. The recommendations on the waste wood management and the possibilities to use the model for other case studies are given in the conclusion.

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1. Introduction

The wood resource is one of the most important material flows used by human society. Its consumption leads to waste wood generation at the end of the wood product life cycle. Waste wood recovery by thermal treatment with energy recovery or by recycling allows the substitution and conservation of primary resources. In European countries, the trade of waste wood was mainly intended for the panel industry but an increasing share of waste wood is now used for the production of electricity and heat (Mazzanti and Zoboli, 2013) as in Italy, Germany (Kharazipour and Kües, 2007) or France (PIPAME, 2012). The introduction of policies to promote renewable energy explains this increase. Moreover, the incineration remains the privileged treatment for the disposal of the preserved and impregnated woods within the majority of European countries (Humar et al., 2006).

Various studies indicate that the cascade use and/or the recycling of waste wood give better environmental and energy impacts than its immediate energy recovery (Börjesson and Gustavsson, 2000; Perez-Garcia et al., 2005; Rivela et al., 2006; Sathre and Gustavsson, 2006; MacFarlane, 2009). On the other hand, other researchers also arrive at opposite conclusions (Morris, 1996; Dodoo et al., 2009; Luoranen et al., 2009). Waste and Resources Action Program (WRAP) specifies that energy recovery from waste wood "is preferable for energy demand while recycling is preferable for climate change potential" (WRAP, 2010) according to their literature review on life cycle analysis of treatments and disposal of waste wood. These contradictory results reveal that no generalization can be done concerning the impact of waste wood management in a given area. This requires a case-by-case analysis.

Swiss federal cross-cutting strategies on biomass (FOEN, 2009b; SFOE, 2010b) and federal sectorial policies of waste (FOEN, 1986, 1992), energy (SFOE, 2013), climate (FOEN, 2013b), forest (FOEN, 2013c) and wood resource (FOEN, 2008a) affect the Swiss waste wood management. These policies and strategies have different goals that individually or jointly laud at the cascade use of wood, the recycling or the energy recovery by thermal treatment of waste wood. This can lead to tensions on the waste wood market that can in turn cause the emergence of a conflict of use among the recycling industry and the waste-to-energy sector such as that on the French

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market (PIPAME, 2012). Thus, the Swiss government acknowledges the presence of possible tensions between the wood resources policy and energy policy where "the promotion of the energetic use of wood by energy policy is not coordinated with the objective of the resource-efficient use of wood (cascade use)" (FOEN, 2008a). In addition, Swiss experts recognize that the increase of renewable energy demand boosts that of biodegradable wastes and thus, "giving rise to a real battle over waste" (Schenk, 2011). This situation occurs in a new energy and climate context. First, following the Fukushima nuclear disaster, the Federal Council and Parliament took the decision of a gradual phasing-out of nuclear energy in Switzerland (Federal Council, 2013) without compromising the greenhouse gas (GHG) emission reductions targets. Secondly, the revision of the CO_2 Act takes into account the carbon sequestration by wood used in the building sector as carbon sinks (Swiss Confederation, 2011; FOEN, 2012c). These sinks are interesting from climate point of view because the wood fixes the carbon in the anthroposphere.

The aim of the present research is to assess the coherence of waste wood management in Switzerland. Waste wood includes the hazardous and non-hazardous post-consumer or post-use wood products founding in municipal, construction & demolition waste but also in industrial and commercial waste (e.g. packaging or furniture). The residual woods from primary and secondary industries are excluded from the scope of the study. The policy coherence, in sense of policy consistency, refers to obtaining assurance of the absence of obstacles or contradictions among different goals of public policies (Jones, 2002) or assurance of the goals integration "without compromising the integrity of each goal" (Duraiappah and Bhardwaj, 2007). To reach the aim of the study, the research will simultaneously address the Swiss waste wood management by a quantitative and qualitative approach. The quantitative approach will serve to compare the additional climate and energy impacts of the current thermal treatment of waste in Switzerland with the alternative option of the waste wood cascade treatment on Swiss territory. A material flow analysis (MFA) methodology is used to model the wood resource and waste wood metabolism on one century time scale. Our hypothesis states that the cascade use of waste wood (waste wood recycling on Swiss territory followed by its thermal treatment) would provide a better overall long-term impact on the climate change mitigation and the renewable energy production as opposed to its immediate thermal treatment. In addition, a qualitative study by documentary analysis is performed in order to identify and understand the determinants of the Swiss waste wood management. The coherence assessment comes from the comparison of the results of the two approaches.

The structure of this study is as follows. Section 2 presents a brief background of Swiss wood consumption and waste wood management and a literature review on waste wood management in Switzerland. Section 3 describes the methodologies of the two approaches. Section 4 presents the results of the approaches and the assessment of the coherence of the waste wood management. Section 5 contains the conclusions, the recommendations about the waste wood management and the possibilities to use the model for other case studies.

2. Background and literature review

The wood resource is the only material flow consumed in Switzerland where its environmental footprint is not in ecological deficit (Swiss Statistics, 2006). Wood constitutes the second most significant material flow (Schmid and Kohler, 2008) and the first biogenic material flow (Baum and Baier, 2008) consumed in Switzerland. Three sectors use this resource: fuelwood (47%), paper and cardboard (25%) and wood products (28%) (FOEN, 2011a). The wood products and goods are mainly employed for the construction, interior design, furniture and packaging (Neubauer-Letsch et al., 2012). The wood ratio in the Swiss buildings remains low, less than 5% (Swiss Statistics, 2010), compared to the wood ratio in North American and Nordic European Countries, more than 75% (Gustavsson et al., 2006). Over the past five years, an average of 1,599,000 m^3 of waste wood was generated on Swiss territory (FOEN, 2012b). Of this quantity, 55% were exported and the rest followed a thermal treatment with energy recovery (FOEN, 2011a, 2011b).

Various studies have been conducted on the Swiss waste wood management, its energy potential and its impact on the climate system. Werner et al. (2002) identify two reasons justifying the rejection of waste wood recycling in Switzerland. First, a portion of this waste is contaminated by harmful substances (e.g. heavy metals or organic substances) and, therefore, must be incinerated. Second, the use of recycled wood as secondary raw material forms a barrier that prevents full exploitation of the Swiss forest. Previous studies from Werner, Taverna and Hofer (Werner et al., 2005, 2006, 2010; Taverna et al., 2007) examine the potential of reducing Swiss GHG emissions from the use of wood in the anthroposphere and the incineration of waste wood. In their final research, theirs conclusions are that the wood thermal treatment is preferable to recycling because it minimizes the risk of dispersion of pollutants contained in the waste with respect to the principles of precaution and closeness. Furthermore, energy recovery from waste wood and the efficient use of wood residues in Switzerland "is one of the key strategies for the reduction of domestic greenhouse gas emissions" (Werner et al., 2010). The waste wood thermal treatment represents 9% or 3.87 PJ of bioenergies exploited in Switzerland (Oettli et al., 2004; Steubing et al., 2010). This value is higher than the world average where the recovered wood share of the global primary biomass resource for energy use is 6% (Edenhofer et al., 2012). The energy production from waste wood amounts to less than 0.4% of the national energy demand or 1.6% of the domestic production (FOEN, 2012a). The exploitation of its full sustainable potential, here 700,000 t by 2040, has the capacity to supply from 4.2 PJ to 7.7 PJ (Oettli et al., 2004). The calculations of Taverna et al. (2011) underscore that energy recovery of waste wood avoids the emission of 116,000 t of GHG by energy substitution, equivalent to a 0.2% increase in Swiss emissions. Furthermore, banning its export raises this value to 360,000 t.

3. Materials and methods

3.1. Research design for the quantitative approach

A model is developed for the quantitative study of the impacts of various waste wood management scenarios for a century. A model is a representation of a complex phenomenon where only the essential elements are included (Soetaert and Herman, 2008). The present model is employed as an analytical and predictive tool.

3.1.1. Definition and conceptualization of the model

This determinist model covers the metabolism of wood resource and waste wood in the Swiss anthroposphere over the 2010–2110 period and uses the MFA methodology (Brunner and Rechberger, 2003). The model conceptualization comes from the material balances of Swiss wood (FOEN, 2011a) and Swiss biogenic goods (Baum and Baier, 2008) that constitute the skeleton of the model and integrate the processes of extraction, transformation and consumption of wood resource and the energy recovery of waste wood in a waste incineration plant or a waste wood boiler. The model forms an open system that includes the foreign trade of wood and waste wood. A recycling alternative process for waste wood is added in

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