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Environmental, economic and social costs and benefits of a packaging waste management system: A Portuguese case study

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ABSTRACT

The impact of the management of packaging waste on the environment, economic growth and job creation is analyzed in this paper. This integrated assessment intends to cover a gap in the literature for this type of studies, using the specific case study of the Portuguese packaging waste management system (SIGRE).

The net environmental benefits associated with the management of packaging waste, are calculated using the Life Cycle Assessment methodology. The results show that, for the categories studied, the impacts associated to SIGRE's various activities are surpassed by the benefits associated to material and energy recovery, with special focus on recycling. For example, in 2011 SIGRE avoided the emission of 116 kt CO_2 equiv. – the equivalent carbon emission of the electricity consumption of 124.000 households in Portugal.

The economic impact of SIGRE is evaluated through Input–Output Analysis. It was found that SIGRE's activities also have a significant economic impact. For example, their added value are ranked amongst the upper third of the economic activities with highest multiplier effect at national level: this means that for each Euro of value added generated within SIGRE, 1.25 additional € are added to the rest of the economy (multiplier effect of 2.25).

Regarding the social impacts of SIGRE, the number of direct jobs associated with the system is estimated to be more than two thousand and three hundred workers. Out of these, 83% are connected to the management of municipal waste packaging (selective collection and sorting), 15% are connected to the management of non-municipal packaging waste and only 2% are connected to the Sociedade Ponto Verde (SPV, green dot society in English) – the management entity responsible for SIGRE.

In general terms, the results obtained provide quantitative support to the EEA (2011) suggestion that moving up the waste hierarchy – from landfilling to recycling – creates jobs and boosts the economy.

1. Introduction

A shift to a green economy – an economy that generates prosperity while maintaining a healthy environment and social equity among current and future generations (EEA, 2011) depends on the promotion of recycling, particularly if it enables reducing environmental impacts from raw material extraction and materials processing. As suggested by the EEA (2011), recycling generates jobs, provides business opportunities and ensures secure supplies of essential resources. However, understanding the contribution of recycling activities to the green economy is difficult – e.g. impact on employment – mainly because economic and environmental data are not structured for that particular focus.

A literature review finds that there is a consistent knowledge base associated to environmental assessment of waste management systems e.g. Lazarevic et al. (2010), Lenzen et al. (2010),

Abbreviations: EEA, European Environment Agency; ELCD, European reference Life Cycle Database; GDP, gross domestic product; GHG, greenhouse gases; GVA, gross value added; LCA, life cycle assessment; MWS, municipal waste systems; NACE, general nomenclature for economic activities; REC, recyclers; ROE, rest of the economy; SIGRE, Portuguese packaging waste management system; SPV, Sociedade Ponto Verde (Green Dot Society); UNEP, United Nations Environment Program; VIM, information and motivation value; VLR, net payback value; VPV, Valor Ponto Verde (green dot value); WIO, waste Input–Output; WMO, waste management operators.

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Table 1
Packaging waste quantities managed by SPV through SIGRE in 2011.

Flow/Material (t)	Steel	Aluminum	Wood	Paper and cardboard	Plastics	Glass	Others[a]	Total
Packages placed in the market								
Urban system	44.978	8.778	3.258	220.746	182.256	397.371	2.004	859.391
Extra-urban system	6.296	274	51.243	164.140	16.902	13.016	505	252.376
Total	51.274	9.052	54.501	384.886	199.158	410.387	2.509	1.111.767
Household packaging waste (municipal system)								
Recycling	18.676	840	4.516	104.907	47.933	210.422	0	387.295
Organic recycling (composting)	0	0	0	5.401	0	0	0	5.401
Energy recovery	0	0	215	27.105	42.715	0	0	70.036
Landfill	26.302	7.938	0	83.333	91.608	186.949	2.004	398.133
Total	44.978	8.778	4.732	220.746	182.256	397.371	2.004	860.865
Industrial and commercial packaging waste (Extra-urban system)								
Recycling	30.294	503	38.013	216.895	25.840	6.736	0	318.281
Unknown	0	0	11.757	0	0	6.280	505	18.542
Total	30.294	503	49.769	216.895	25.840	13.016	505	336.823
Total municipal + urban systems	75.272	9.281	54.501	437.641	208.096	410.387	2.509	1.197.688

[a] "Others" include materials such as textiles.

Merrild et al. (2008) and there are studies that combine both environmental and economical evaluation e.g. Larsen et al. (2012), Emery et al. (2007), Reich (2013). However, very few references combine environmental, social and economical tools in an integrative, triple-bottom line analysis of dedicated waste management systems (e.g. Klang et al., 2003). This paper contributes to fill this gap by offering a set of methodological approaches that contribute to quantify the environmental, economic and social impacts of the Portuguese integrated packaging waste management system, SIGRE.

The European Union Directive on Packaging and Packaging Waste (Directive 94/62/EC) was the precursor of SIGRE, which is managed by Sociedade Ponto Verde – Green Dot Society (SPV). SPV is a non-profit organization, which is owned by the companies that distribute products whose packaging falls within the scope of the Directive. In practice, SIGRE includes a circuit that ensures the collection, recycling and recovery of non-reusable packaging waste, organized and managed by SPV.

Currently, SIGRE comprises two subsystems with different management models: (1) management of household and small service companies packaging waste (municipal system); (2) management of industrial, commercial and big service packaging waste (extra-urban system).

In the municipal system, SPV provides financial support to the municipalities and/or its Municipal Waste Systems (MWS), to encourage the collection and/or sorting systems for packaging waste from households and small services' companies. This waste is sent to recycling through existing partnerships with pre-qualified recycling processors. The remaining packaging waste can be directed to composting, energy recovery or simply landfilled if there are no other options available. In the case of the extra-urban system, which processes wastes produced in industries, commerce and large service companies, SPV provides a financial incentive to certified waste management operators (WMO), which collects and transports this waste for recycling.

We estimate that 711 thousand tons of packaging wastes were sent for recycling out of a total of 1.198 thousand tons of waste packaging managed by SPV through SIGRE, as quantified in Table 1. If we consider the total amount of packaging placed in the market, these numbers imply an overall recycling rate of 64% and a recovery rate of 70%. If we consider the household packaging waste alone, the recycling and recovery rates stands at 46% and 54%, respectively.

This paper is organized in six sections, including this introduction. Section 2 presents the methodological frameworks adopted to support the quantification of the environmental, economic and social impact of the waste packaging management system. Sections 3–5 provide the main results obtained and Section 6 draws the main conclusions.

2. Methodological framework and data sources

2.1. Environmental assessment

The environmental assessment was performed using the methodology of life cycle assessment (LCA), which requires the compilation of data for the most representative material and energy inputs and outputs of the processes under analysis, and the evaluation of their associated environmental impacts (ISO 14040, 2006). For the present study, the Unit Function selected for reference was "total packaging waste managed by the SPV under SIGRE in 2011", which corresponds to the type of wastes presented in Table 1. It is important to remind that SPV manages all waste packaging that enters SIGRE, regardless if it is packaging from a financial contributor of the system or not.

LCA studies can adopt different approaches, namely the attributional or descriptive model and the consequentional model, presented for example, by Heijungs (2007), Tillman (2000), Thomassen et al. (2008) or Lund et al. (2010). Whereas the attributional LCA model is rather undisputed (theoretically founded by Heijungs, 2007), as discussed by Frischknecht and Stucki (2010), the appropriate approach to model the effects of a decision is still subject to debates. The main point of discussion is whether or not actual economic relations are followed to identify the suppliers in the situation after the decision has been taken. Some proponents of the consequential approach (Ekvall and Weidema, 2004) use market information and price elasticities to identify those suppliers that are affected by the decision and will increase or decrease their production. Others plea for the consideration of the actual (future) suppliers based on factual or anticipated economic business-to-business relationships (Frischknecht, 1998).

In this paper, the model adopted for the calculation of the environmental impacts associated with SIGRE was the "attributional model". Both municipal and extra-urban systems were modeled according to their 2011 setting, and co-products were taken into account by the "substitution by system expansion" or "avoided burden method" (Finnveden et al., 2009), considering the average primary route market consumption mix.

The "consequential approach" was used in scenario analysis of the avoided impacts resulting from the recovered packaging materials, as in the case of the electricity production, where the environmental profile resulting from the use of the average