

FENIX: A COMPREHENSIVE ON-LINE TOOL FOR EVALUATING PACKAGING WASTE MANAGEMENT OPTIONS IN SPAIN AND PORTUGAL

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ABSTRACT

Life Cycle Assessment is increasingly being applied to assist decision making in waste management policy and planning throughout Europe. Most of the existing software tools are either too general in scope, or not flexible enough. The goal of the LIFE+ project ‘FENIX – Giving Packaging a New Life’ was to create an *ad-hoc* software tool for evaluating alternative scenarios for the management of post-consumer packaging waste. Now finalized, such tool allows a large degree of flexibility, all the while ensuring the physical soundness of the underlying model, by enforcing a rigorous mass balance, and by pre-defining the most representative processes and technologies among which the user is allowed to choose.

INTRODUCTION

Light packaging waste accounts for approximately 38% by weight of the total municipal solid waste generated in the EU-27, and this figure is on the rise [Eurostat, 2011]. Packaging waste merits special attention since it is energy-intensive to produce, entails complex collection and transport logistics (partly because of its typically low density), lends itself to a wide range of possible end-of-life treatments (landfilling, recycling and incineration with energy recovery), and, in the latter two cases, has potential for high material and energy recovery rates. Life Cycle Assessment (LCA) has largely established itself as the methodology of choice for the evaluation of the potential environmental impacts of human-dominated processes and systems along their full life cycles, ‘from the cradle to the grave’ (or even ‘from the cradle to the cradle’, thereby explicitly including material recycling to give birth to second-generation product systems). LCA is especially useful in analysing alternative options, highlighting the trade-offs between them, and thereby helping to single out the most preferable one(s) overall, while avoiding the pitfall of unintentional impact shifting (between different geographical areas, life cycle stages or impact categories).

The waste management sector is a particularly complex type of system due to its multi-branched structure and its being closely intertwined with primary and secondary material and energy production systems. It is thus especially important to apply a rigorous LCA approach to its analysis, in order to arrive at sound and objective conclusions on its environmental

performance. Most of the existing software tools, however, are often either too general in scope, requiring specific knowledge to set up and operate, or on the other hand not flexible enough to fully take into account the broad spectrum of available options (specifically, the waste collection phase is typically only accounted for by means of relatively crude deterministic models, which are of limited value in predicting the environmental performance of alternative collection methods or routes).

In order to make the most of the potentiality of LCA for the strategic planning of waste management options (as suggested by the EU Thematic Strategy on Waste Prevention and Recycling), and for light packaging waste in particular, it was recognized to be necessary to develop a new flexible and user-friendly software tool based on high-quality technical and scientific data. The 'FENIX – giving packaging a new life' project ensued, funded by the European Union's LIFE+ programme, and carried out by a consortium of four main partners: UNESCO Chair in Life Cycle and Climate Change of ESCI-UPF, Spain; Ecoembalajes España, Spain; Sociedade Ponto Verde, Portugal; PE International, Germany.

METHODS

From the start, it was deemed a strict requirement that the whole of the FENIX project be firmly rooted in sound Life Cycle Thinking (LCT) principles. Specifically, the following methodological steps were taken.

Data base development

Most of the data to be used in the FENIX software tool were derived from the first-hand investigation of waste management processes and technologies representative of those currently deployed in Spain and Portugal. Data for background processes such as the electricity production mixtures, the production of virgin materials, and the production of chemicals used in the treatment of the waste flows, were instead sourced from existing LCA databases [PE international, 2011; JRC, 2011; Ecoinvent, 2011] and adapted to the local (Spanish and Portuguese) conditions whenever appropriate.

Development of individual LCI models

Individual life cycle inventory models were first developed for all the key processes that form part of the long waste management chain, with the help of thirteen collaborators among universities, technological institutes and research centres in Spain and Portugal.

Structuring of overall waste management model

The individual LCI sub-models listed above have been integrated into a common framework according to the general flowchart illustrated in Figure 1. The tool was designed to allow a large degree of flexibility in terms of mixing and matching the different processes and defining specific waste collection routes. At the same time, the physical soundness of the underlying model is guaranteed at all times, by enforcing a rigorous mass balance, and by pre-defining the most representative processes and technologies among which the user is allowed to choose.

Last but not least, the issue of correctly estimating the impact reductions afforded by recycling was taken into utmost consideration, with special attention directed at ensuring strict methodological consistency across the different materials.

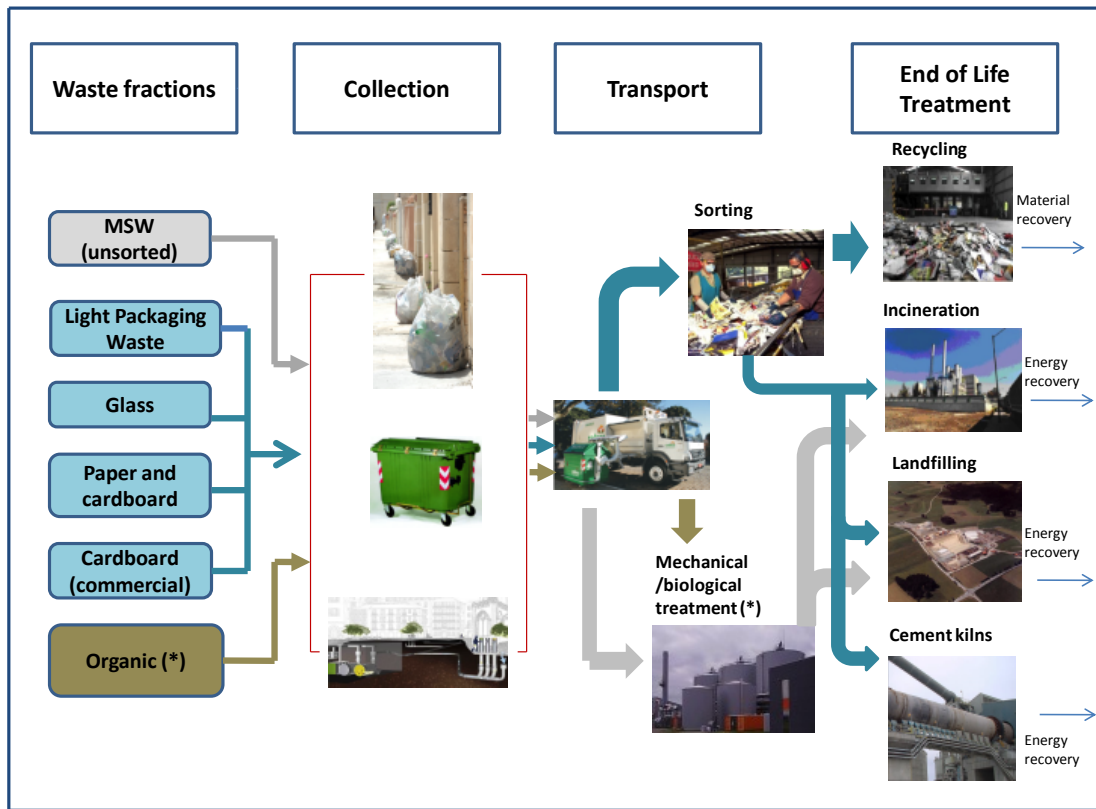


Figure 1. FENIX model flowchart.

(*) Organic waste (present both in the 'organic' waste fraction and in the other fractions as unsolicited waste flow) is only taken into account in so far as its mass affects the *dimensioning* of the collection and transport systems; however, the direct impact associated to its collection, transport and treatment is not accounted for (all impacts are calculated per unit of individual waste flow). Likewise, biological treatment and composting is only included in the boundaries of the FENIX analysis to account for the impact associated to the final disposal of the residual packaging waste that is separated out of the organic waste entering these processes.

Life cycle impact assessment

The following environmental impact categories were selected to be included in the FENIX software tool:

- CML 2002 [Guinée et al., 2002]: global warming potential (GWP - standard characterization factors were modified to exclude the contribution of biogenic carbon), acidification potential (AP), eutrophication potential (EP), ozone depletion potential (ODP), photochemical ozone creation potential (POCP);
- USETox [Rosenbaum et al., 2008]: human toxicity potential (HTP), eco-toxicity potential (ETP).

RESULTS

As originally envisaged, the final outcome of the project has been an *ad-hoc* software tool for evaluating alternative scenarios for the management of post-consumer packaging waste, enabling the selection of more sustainable waste management practices, in accordance with the current European policy principles. The tool is intended to be used directly by the local

municipalities and waste management entities in Spain and Portugal, and therefore a special effort was devoted to developing a user-friendly on-line interface whereby the user is allowed to build their own scenario by simply typing in the waste quantities and selecting the appropriate collection, sorting and treatment (recycling, landfilling and/or incineration) processes. Up to three different and independent waste management scenarios can be defined. A large number of parameters may be adjusted, such as: initial waste composition, type(s) of collection system(s) and relative distances, collection frequency/-ies, type(s) of transference plant(s), selection plant(s) efficiency/-ies, and final EoL treatment options (recycling, incineration, landfill). Access to the tool is web-based and free of charge (but restricted to registered users) and available in three languages (English, Spanish and Portuguese); three categories of users are pre-defined, each enabling access to increasing levels of model complexity.

DISCUSSION

All the individual steps leading up to the FENIX tool (new data base entries, LCI sub-models) were subject to rigorous external review by internationally renowned LCA and waste management experts. In parallel, a number of seminars were held to openly discuss and vet all key assumptions and methodological decisions, so as to achieve the widest possible agreement and contribute to the advancement of the state of the art in the LCA of waste management systems.

CONCLUSIONS

After the successful closure of the project, the FENIX software tool is now on the verge of being adopted by the Spanish and Portuguese Green Dot Holders, and it is expected to play a major role in improving the management of packaging waste in those countries, based on sound life cycle principles. With minor adaptations, its transferability to other European countries is also a foreseen possibility for the near future, with the Czech Republic being identified as the first likely candidate in this sense.

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