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Participatory approach, acceptability and transparency of waste management LCAs: Case studies of Torino and Cuneo

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ABSTRACT

The paper summarises the main results obtained from two extensive applications of Life Cycle Assessment (LCA) to the integrated municipal solid waste management systems of Torino and Cuneo Districts in northern Italy. Scenarios with substantial differences in terms of amount of waste, percentage of separate collection and options for the disposal of residual waste are used to discuss the credibility and acceptability of the LCA results, which are adversely affected by the large influence of methodological assumptions and the local socio-economic constraints. The use of site-specific data on full scale waste treatment facilities and the adoption of a participatory approach for the definition of the most sensible LCA assumptions are used to assist local public administrators and stakeholders showing them that LCA can be operational to waste management at local scale.

1. Introduction

Life Cycle Assessment (LCA) applied to sustainable municipal solid waste management has rapidly expanded over the last few years as a tool that is able to capture and handle complexities and interdependencies typically characterising modern integrated waste management systems (I-WMS).

A recent, fairly comprehensive and extensive literature review by Pires et al. (2011b) pointed out to what extent a system approach is becoming strategic in order to take into account many technical and non-technical aspects of solid waste management systems. In fact, I-WMSs should be analysed as a whole, since they are inter-related with one another and developments in one area frequently affect practices or activities in another area. The same authors (Pires et al., 2011b) classified nine system assessment tools commonly used in waste management (WM), among which LCA clearly emerged as the most popular, scientifically sound and worldwide appreciated.

The context, objectives and operational conditions that characterise the growing number of recently published LCA applications to WM are quite variable.

With reference to the European countries and the most recent legislation published by the European Commission (EC), i.e. the Waste Directive 2008/98/EC (EU, 2008), in the geographical areas where WM is closer to the EU targets of sustainability, LCA is mostly used to rationalise technological choices and management strategies, while in less advanced regions LCA is used to develop measures to implement more integrated solid waste management and reach EU directives.

As reported in Rigamonti et al. (2010), several LCA studies deal with the I-WMS as a whole (i.e. from a system perspective), while other studies are focused on single subsystems (or groups of subsystems taken individually) devoted to the treatment of single waste fractions.

Although the LCA methodology and the WM related tools are rapidly expanding, there are still uncertainties and open issues, which are challenging the scientific community and that, are limiting the diffusion among end-users. Thus, the question "What life-cycle assessment does and does not do in assessments of waste management" raised by Ekvall et al. (2007) is still partially unanswered and still of great interest.

One of the key issues is understanding what LCA can do for local waste authorities and operators. Moreover, it is still unclear to what extent these subjects are aware of the potential of WM LCAs and/or are willing to put into practice the results.

LCA can supply objective and comprehensive information, but, in Italy and elsewhere, the final decision lies mostly with public

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administrators seldom aware of the great potential of LCA. Such public administrators often set up priorities and take decisions more on financial constraints rather than on environmental optimisation issues (Blengini, 2008).

Beyond the great advancements of the scientific community, the central question is therefore: "is WM LCA fully operational to business?" In other words: "is LCA accepted, used, understood and put into practice by all the stakeholders?".

LCAs of complex and inter-dependent systems such as WMs necessarily reflect complexity, which is also influenced by non-technical factors, site-specific aspects and local socio-economic constraints. Therefore, LCAs are difficult to be handled and/or developed by non-experts. Moreover, the results of a LCA applied to an I-WMS are unique and should never be generalised, though a lesson can be learned. Consequently, the most important message from a WM LCA should not be the final results, but rather a combination of the results and the way LCA was conducted.

In order to develop meaningful LCAs of I-WMS: (1) goal and scope must be clearly identified, justified and outlined; (2) both input data and inventory results must be fully made available and it should be possible to mathematically manipulate them. Numerical results unsupported by assumptions and the full dataset might be of limited importance.

Two examples taken from the literature might help clarify the context. Rigamonti et al. (2009, 2010) have shown to what extent the selection efficiencies, the adopted technologies and the methodological assumptions related to avoided products might drastically change the overall environmental performance of WM subsystems. A similar picture is presented by Merrild et al. (2008) in case of wastepaper recycling vs. incineration, where the overall energy and environmental indicators can change from positive (net impact) to negative (net gain) depending on the combination of the adopted technologies.

The consequence of the large variability of the environmental performance of subsystems, which heavily depends on assumptions, becomes exponential when dealing with an I-WMS. Moreover, when also socio-economic constraints are taken into account, including, for instance, the preferences of stakeholders relevant to different areas of environmental concern, it is very possible that LCA results become subjective to a large extent, with consequent increased scepticism and loss of credibility and acceptance. This is a very important area of concern that represents an obstacle to the diffusion of WM LCAs, and is also the central point of the present article, where two extensive LCAs run by the Politecnico di Torino in the years 2008 and 2009 (Blengini et al., 2008, 2009) are used in order to discuss on strategies to boost adoption of LCA in WM in northern Italy, and elsewhere, and increase the credibility and acceptability of results.

The original contribution of the present paper can be summarised as follows:

- Use of site-specific data on full scale waste treatment facilities in the study area in order to cover all the WM activities in the I-WMS and the full life cycle of waste;
- use of the participatory approach in order to address the most sensible LCA assumptions and propose solutions in order to enhance the acceptability of results;
- assist the local public administrators in order to verify and quantify the effectiveness of EU strategies on WM using site-specific data and taking into account the local socio-economic constraints, emphasising that LCA application is both useful and feasible.

2. Model and data development

The paper presents a synthesis and the main results of two research programmes focused on the application of LCA to a set of WM scenarios in Torino and Cuneo Districts in northern Italy (Blengini et al., 2008, 2009). The study area covers a population of nearly 2800,000 inhabitants with an annual generation of nearly 1500,000 tons of municipal solid waste (Fig. 1). In both cases, the overall objective was identifying scenarios with best energy and environmental performance. A detailed energy and environmental analysis was carried out for the main components of the I-WMS and for the I-WMS as a whole in order to support public administrators towards sustainable waste management.

The above research programmes were developed by the Politecnico di Torino and funded by the WM Authorities of Torino and Cuneo Districts. LCAs were implemented using the SimaPro 7 software (SimaPro7, 2006).

All the subsystems included in the I-WMS were considered and analysed paying attention to energy and environmental implications and inter-dependencies. Separate collection (SC) and its downstream recycling chains were investigated in terms of environmental benefits and impacts, in order to quantify advantages and drawbacks that can be ascribed to the new objectives of SC (65% by the year 2012) introduced by the law presently in force in Italy (Dlgs.152/06). At the same time, the role and environmental implications of energy recovery from residual waste were analysed, paying attention to the consequences of possible pre-treatment options of the residual waste, and considering both incineration and co-incineration.

2.1. Definition of goal and scope through a participatory approach

The LCA methodology according to ISO 14040 (2006) is worldwide accepted and appreciated because it allows an objective evaluation of the environmental performances of products and processes (Guinée, 2002).

However when applying LCA to WM, there are some sector-specific aspects that must be considered and assumptions to be undertaken that might affect the results to a large extent (Ekvall et al., 2007; Finnveden, 1999; Merrild et al., 2008; Rigamonti et al., 2010).

In order to keep under control the negative influence that assumptions might have in terms of acceptability of the results, a participatory approach was adopted since an early stage of the research. When applied from the very beginning, a participatory process may be of help in reducing possible conflicts among opposite interest groups, which is typical in waste management, and contribute towards defining acceptable solutions for all involved parties (Salhofer et al., 2007b). As it was observed in other case studies, where a structured participative approach was applied to waste management, different stakeholders have different objectives (Pires et al., 2011a) and some of them might try to influence the results by changing the criteria in a late stage (Salhofer et al., 2007b). Setting up clear and shared rules and preferences since the beginning is therefore a key issue (De Marchi et al., 2000).

A panel of stakeholders and experts, including participants from Politecnico di Torino, WM authorities of Torino and Cuneo Districts and Environmentalist NGOs, was set up. The trans-disciplinary nature of the panel was similar to those presented in De Marchi et al. (2000) and in Salhofer et al. (2007b), where attention was paid to include all local actors and give them equal opportunities to express their opinion.

An initial brainstorming and subsequent structured meetings were used in order to reach a shared definition of the following aspects that, as the participants revealed, can highly increase the acceptability of the LCA results:

- Identification and description of the scenarios to be compared: amount of waste, composition, percentage of SC, definition of technologies/strategies not yet defined in the local WM policies/plans;