Use of Life Cycle Assessment (LCA) as a Policy Tool in the Field of Sustainable Packaging Waste Management

A EUROPEN DISCUSSION PAPER

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This paper provides an update on the usefulness of Life Cycle Assessment for policy making in the field of packaging waste management. It looks specifically at whether LCA can be used to scientifically support a hierarchy for packaging waste management.

There is a need to evaluate the potential of Life Cycle Assessment (LCA) for policy-making purposes in the area of packaging waste. Although industry has been using LCA for a number of years to achieve continuous environmental improvements, experience suggests that to set EU wide public policy on the basis of LCA results would be inappropriate. Such a process would only restrict the freedom of managers to innovate in the field of packaging development and packaging waste management and would limit consumer choice.

LCA's have been used increasingly by industry and the public sector to help reduce the overall environmental burdens across the whole life cycle with the aim of contributing to the development of sustainable product life cycles. This allows benchmarking of product system options that involve source reduction, re-use, return, recycling or inclusion in energy recovery or landfill.

LCA is a decision supporting tool not a decision making tool. It should be used in conjunction with other tools to assist in identifying areas of potential ecological improvement that will support sustainable development. LCA-based product/service comparisons rarely produce clear "winners and losers". Such comparisons demonstrate the environmental implications of different choices and the trade-offs that need to be made.

A recent European Commission funded report has shown that an LCA study for packaging waste is unlikely to produce a universal, regional or even national hierarchy between reusable and non-reusable packaging. It agrees that a case-by-case approach is necessary, and that 'regional or local conditions to a large extent determine which of the options (reuse, recycling, or recovery) is preferent from the point of view of a high level of environmental protection'.

The benefit of LCA is that it provides a flexible and dynamic alternative that is able to take account of local conditions rather than a rigid hierarchy of options. The overall aim must be to maximise the efficiency of resource use throughout the product life cycle. In some cases, LCA has demonstrated that reuse and recycling of packaging materials can actually increase environmental burdens compared to disposal.

Efforts should also be made to develop truly integrated waste management systems, which use a range of options to reduce the overall environmental burdens of waste management. Solid waste LCA's, run by waste managers and planners, can be used to help design such systems. The combination of these efforts is more likely to result in sustainable packaging waste management than efforts based on a policy limited by a rigid packaging waste hierarchy.

The role of LCA within any waste management policy must be as a continuous benchmarking tool to maximise efficiency of resource use through a case by case approach.

■ INTRODUCTION

In 1996, EUROPEN published a discussion paper that considered the usefulness of Life Cycle Assessment (LCA) for policy making in general and for policy making in the field of packaging waste management in particular[(1)]. During the intervening three years much has happened in the LCA and packaging waste arenas including the publication of a Commission funded study on the use of LCA for policy making[(2)], the implementation of legislation by several more European Union (EU) member states in response to the EU Directive on Packaging and Packaging waste (P&PWD) and an increase in priority for Sustainable Development.

The European Union Directive on Packaging and Packaging Waste [(3)] states that .."life cycle assessments should be completed as soon as possible to justify a clear hierarchy between reusable, recyclable and recoverable packaging". However, a recent Commission funded study (2) concludes that such an EU-wide hierarchy cannot be supported by LCA. There is concern that to attempt to do so would actually run counter to ecological improvements in production, consumption and waste management and move us further away from our goal of sustainable development. It is also difficult to see how this approach can be reconciled with The Commission's desire to implement an Integrated Product Policy (IPP). The Commission has stated that 'IPP will be developed with and not against the market (this is not only true for principle of the market-based economy but also for the internal market and the international market)' [(4)]. The use of LCA for EU wide public policy making will ignore local, regional and international market conditions.

On the other hand, the use of LCA by waste managers is becoming increasingly standard practice and in many cases has led to significant improvements in the management of solid waste [(5)]. These improvements have been achieved on a local scale, based on a local, LCA-derived hierarchy rather than a rigid "EU-wide" hierarchy that does not account for local conditions.

■ LIFE CYCLE ASSESSMENT (LCA) AND SUSTAINABLE DEVELOPMENT

LCA attempts to predict the overall environmental burdens associated with providing a specific product or service to society on a cradle to grave basis. Compared to other environmental management tools, LCA has two unique benefits [(6)]:

* LCA attempts to consider the whole life cycle of the product or service. This helps prevent "problem shifting" in which an apparent improvement in one part of a life cycle can merely lead to further problems at another time or place.
* LCA tries to calculate the burdens related to the function provided by the product or service. This allows a value:impact assessment to be considered [(7)]

Balanced against these benefits, there are also limitations to the usefulness of LCA, not least of which is that LCA does not address the economic or social factors mentioned previously. These areas are outside the boundary of an environmental LCA, but must be taken into account in any policy or decision-making process, especially in the context of sustainable development. Other limitations include:

* LCA comparisons rarely produce clear "winners and losers"; rather they show the environmental implications of different choices and the trade-offs that need to be made.
* LCA is but one tool in the "environmental management toolbox". Although it takes a life cycle approach, LCA does not address all areas of environmental management. It cannot, for example, assess site specific human and environmental safety (this requires a risk assessment). Consequently a framework of different environmental management tools is needed to support decision making; LCA alone is not sufficient [8, 9]. This is often a point of confusion between LCA scientists and others, with the latter considering that LCA is, can be, or should be the single, holistic tool for making environmental decisions [10]. Inappropriate use of LCA, such as that by the Danish Government to maintain the ban on beverage cans, has interfered with the principle of fee trade within the Union.
* An LCA study relates to one specific product system at one defined point in time. A study of current systems would not indicate what would be the better option in 5 years time; this would require a separate study using different data, reflecting future opportunities not always apparent at the point when the study is conducted.
* The recent addition by ISO of guidelines for impact assessment and interpretation to those for goal definition and the inventory stages of the process [11], has firmly established LCA methodology. However, it will take time before comprehensive databases are established. Some EU States have begun to formulate their own rules for performing LCA's based on the ISO 14040 standards [12]. Observing such commonly derived rules on a national and European level will help to exploit even more of the opportunities that LCA methodology has to offer.

Despite these limitations, LCA has been widely used within industry to identify improvement opportunities in two main areas. Designers and manufacturers have used LCA to optimise individual products and their packaging, whilst waste managers are starting to use LCA to optimise defined waste management systems.

■ APPLICATION OF LCA TO SUSTAINABLE PRODUCTS AND PACKAGING

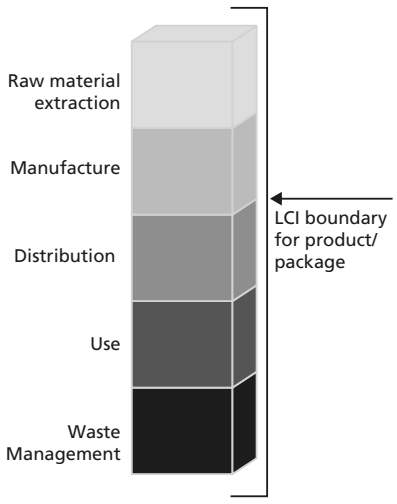

Figure 1. Boundary of the LCA for a Product or Package

The majority of LCA studies to date have looked at individual products or packaging systems and have considered the whole life cycle (Figure 1). These product based LCA's have been employed by the designers and manufacturers to help reduce the overall environmental burdens across the whole life cycle with the aim of developing sustainable product life cycles. This allows benchmarking of product system options that involve source reduction, re-use, return, recycling or inclusion in energy recovery or landfill. In many cases this has resulted in commonly held views such as 'recyclable or re-usable packaging must be better' being challenged. For example, LCA has demonstrated that non readily recyclable plastic pouches for detergents would outperform the more recyclable bottle in terms of energy consumption, air and water emissions and solid waste, since they used much less material in the first place [13].

Thus, by considering all stages of the life cycle and not only its post-use phase, an LCA can help provide a product/package to society in the most resource-efficient way. A product/package LCA cannot, however, be used to select waste infrastructures, since such systems need to consider all of the waste stream, rather than individual products or packages.

■ APPLICATION OF LCA TO SUSTAINABLE INTEGRATED SOLID WASTE MANAGEMENT

Irrespective of how well optimised each product and package life cycle may be, there will inevitably be some post-use solid waste to be managed. LCA can again contribute to sustainable development during this phase of the product/package life cycle by identifying where more value can be extracted from the waste prior to final disposal. This could be as recovered secondary materials, compost and/or energy or from the consumption of less energy and other resources in the process.

When considering the treatment of solid waste, LCA is used to help selection of the optimal system and infrastructure to handle all waste streams in a given system (Figure 2).

Clearly the two LCA tools overlap but they represent two distinct tools for two different user groups. Computer models for conducting LCA's for waste management systems are already available for use in Europe [14], Canada [15] and elsewhere. Several more sophisticated models are under development, including those from the UK Environment Agency [16] and the US Environmental Protection Agency [17]. Although it is recognised that reliable data is not always available, these models can be used to design the best waste management system for any given area on a case by case basis. Each system will depend on local

needs and priorities, such as the need to reduce landfill requirements, or the desire to reduce water emissions or air emissions.

Given that LCA is useful to help reduce the overall environmental burdens of product or package life cycles, and is also of use in optimising the waste management systems of specific areas, can it be used to set public policy?

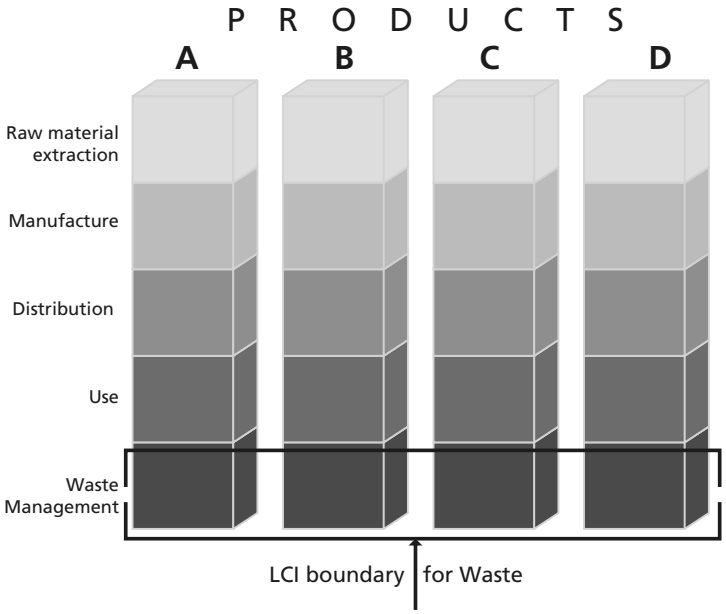

Figure 2. Boundary for the LCA of Solid Waste

■ USE OF LCA FOR PUBLIC POLICY MAKING

Although it will rarely produce clear "winners and losers", LCA can be used to compare specific options. Can this be used to formulate generally applicable environmental policies for the European Union?

It has been suggested that LCA be used for policy making on a Pan European or Regional basis. However, the level of diversity between regions, countries and even within municipalities within countries is so vast that the preferred waste management option must be decided on a case-by-case basis, since there is no overall "best option".

Previously we had argued that because such factors as packaging waste amounts and composition, available infrastructure and markets, and environmental and social priorities vary within countries, let alone across the EU, it is unlikely that there will be one overall best packaging waste strategy for the entire EU [(1)]. The conclusions, although not the recommendations of a recent commission funded study conducted by RDC/Coopers and Lybrand would appear to support this viewpoint [(2)]. The report agrees that a case-by-case approach is necessary, due to variations in local conditions and concludes 'that technologic, material, logistic, market, and regional or local conditions to a large extent determine which of the options (reuse, recycling, or recovery) is preferent from the point of view of a high level of environmental protection.

The report attempts to see if any clear preferences exist between the waste management options or packaging systems studied, but finds that "the ranges are often very wide, so that generally no clear or general preference appears". Similarly when looking at product/packaging systems, the report concludes that "a clear preference or absolute "lowest impact option" is never found".

As there were no clear preferences at the EU level, the report then looked to see if clear preferences apply for specific Member States. Here too, they found the results remained "conditional", with no clear preference. Much is made in the report of such "conditional preferences" but the common theme for all scenarios for preference of reuse, non reuse and material type was that a preference was only obvious if and only if 'many different parameters [are] favourable at the same time in order to have a 'conditional preference'. Given the weak nature of "conditional preferences", it is surprising that the report proposes that they be used to support EU policy. It is even more surprising given the report's finding that with packaging such as for beverages "in all cases it must be stated that in general differences between the options are relatively small and that substantial improvement of the environment would not be easy to achieve by switching from one system to another".

The benefit of even trying to set a policy in such a case is not clear. The report contains little information to alter our previous conclusion that the best way to use LCA is on a case by case basis. This would involve manufacturers continuing to use a product/package LCA to determine the optimum packaging type for a given product, and region, whilst waste managers would continue to use a solid waste LCA to design the most suitable waste management infrastructure for each region.

■ USE OF LCA TO ESTABLISH HIERARCHY FOR PACKAGING WASTE MANAGEMENT

The commonly quoted "waste management hierarchy" varies in its exact form, but usually ranks waste management options in a preferred order: waste minimisation, re-use, materials recycling, composting, energy recovery, incineration without energy recovery, landfilling.

Although such a hierarchy is widespread and often suggested, the value of this approach has serious limitations:

* The hierarchy has no scientific or technical basis.
* The hierarchy is not useful when a combination of options is used. It cannot predict, for example, whether materials recycling with incineration of residues would be preferable to a combination of composting and landfilling. Increasingly, with the implementation of integrated waste management, it is becoming recognised that a combination of recovery and treatment options are required to optimise the management of municipal solid waste.
* The hierarchy does not address cost, so cannot determine whether systems are also economically sustainable.

The RDC report [2] offers little to support the current hierarchy or to suggest an alternative. It claims that "We were able to identify some hierarchy at EU level", but then goes on: "However, this hierarchy in most cases depends on very specific conditions". If these "very specific conditions" are not met, then any hierarchy is invalid. In some cases, the lack of any hierarchy is specifically stated in the report. Another study conducted for the European Commission DGXI has also produced little evidence to support the current waste hierarchy. It suggested a different hierarchy with source reduction preferred, then recycling, landfill, incineration and municipal composting, in that order [18]. Clearly these results indicate that it is more helpful to use LCA to improve the environmental performance of individual systems, rather than try to use it to establish yet another hierarchy of waste management options.

The benefit of LCA is that is provides a flexible and dynamic alternative to a rigid hierarchy of options. Efforts should continue into reducing the amount of packaging waste to be handled in the first place. Product/packaging LCA's, carried out by designers and manufacturers, are part of a continuous process to help ensure that this reduction is done on a life cycle basis. Efforts are also being made to develop truly integrated waste management systems, which use a range of options to reduce the overall environmental burdens of waste management. Solid waste LCA's, run by waste managers and planners, are being used to help design such systems. The combination of these efforts is more likely to result in sustainable packaging waste management than efforts based on a rigid packaging waste hierarchy.

■ CONCLUSIONS

Clearly LCA is not a panacea for all our packaging waste issues. It is a decision supporting tool not a decision making tool that should be used in conjunction with other tools for environmental decision making. LCA can be used to optimise packaging life cycles. LCA also offers waste planners and managers the opportunity to ensure that the solid waste produced by such optimised systems is handled in a sustainable way.

Studies have shown that a universal hierarchy for packaging waste between reusable and one-way packaging does not exist. The preferred option for any given product will vary by product category, and depends on such variables as number of journeys and return distances. Similarly, studies have shown that LCA cannot be used to support a single hierarchy between recycling and energy recovery, since there is no universal 'best' waste management system. The optimal system for any region will vary according to local resources, needs and priorities.

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