Submitted Abstracts not presented at the ACR+/London Remade Conference on Waste and Climate Change (London, 31 Jan. & 1 Feb. 2008)

Topic: Life-cycle analysis and other methods of impact assessment

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Analysis of recovery systems of municipal residual waste

C. Martínez Orgado

Residual waste is the part of the municipal waste deposited in containers without being object of segregation in components for which are implanted systems of separate collection. Therefore, residual waste is composed by materials that can be taken advantage of.

The aim of this project carried out by ISR, which finalisation is foreseen for January 2008, is to analyse and compare the different management systems for municipal residual waste, from the point of view of environmental and economic impacts, especially enhancing in costs, energy efficiency and CO_2 emissions.

It was considered that the most effective tool for this study was a Life Cycle Assessment of waste management according to the standard ISO 14040, using software UMBERTO®, a program that allows modelizing and calculating material and energy flow systems considering different factors, and facilitates the decision making for the optimization of the design of waste management models.

In the study two different cases are contemplated for residual waste, based on separated collection of municipal waste: one, with collection of 4 fractions (glass, paper-cardboard, light packages and residual waste), and the other one, with collection of 5 fractions (glass, paper-cardboard, light packages, organic matter and residual waste).

The analysis of waste management contained in both fractions, includes diverse recovery or elimination possibilities and the substitution of raw materials that comes from recovery and recycling processes.

This analysis of environmental eco-efficiency in different exploitation systems for residual waste is made for two "fictitious management units”, for which is settled down a composition "type" of municipal waste.

For both territories, we make a comparative analysis among different recovery systems for residual waste, from the environmental and economical point of view. Each one of these systems represents a management scenario for residual waste, like the following: incineration with energy recovery, MBT and incineration with energy recovery, BMT and bioreactor (treatment of CSR using emergent technologies and cement plants), BMT and incineration with energy recovery, and MBT and landfill. In the case of separated collection according to 5 fractions it is added a pre-scenario of organic matter collection and composting.

The comparative analysis includes the data collecting and analysis of the inventory, from which is possible to extract the flow models of inputs (matter and resources) and outputs (emissions) for each recovery system. Next, resources consumption and environmental impacts of these inputs and outputs are characterized. The study also implies the analysis and comparison of costs for the different scenarios. Finally, an interpretation of the results is carried out.

Climate change impacts of Waste Management Technologies – Issues associated with technology comparison

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Abstract

This paper aims to analyse the factors taken into account when assessing various waste management solutions for the treatment and disposal of Municipal Solid Waste (MSW), the interpretation of results and how this could influence the choice of waste treatment technology. Different scenarios have been studied modifying waste composition and transport distances and comparing the outcomes in terms of level of recovery and emissions to atmosphere.

It is now accepted world wide that the emissions of Green house Gases (GHG) are altering the climate and that unless we reduce their release to the atmosphere the earth will be facing catastrophic changes.

Up to now waste decisions on management strategies have been made without simultaneous quantification of GHG impact. The situation has recently changed and the local authority sector is realising that GHG emissions has an important role to play in their choice of future waste management infrastructure. Moreover 2007 legislation (Waste Strategy and Energy white paper) has linked the waste and energy sectors making it even more vital.

Legislation and financial incentives have a very important role to play when it comes to choosing which solution to implement. Equally waste quantity and characteristics have a big influence in the choice of technology. However these are not the only key factors and we now have the duty to treat waste as a resource and no longer as something to get rid off.

The major GHG emissions from the waste sector are methane generated from landfill and secondarily, wastewater CH4 and N2O. This paper concentrates on MSW of which a significant proportion is still landfilled. As landfills produce CH4 for decades, thermal and biological treatments and other strategies that reduce landfilled waste are complementary reduction measures to landfill gas recovery in the short to medium term. The primary objective of the EU landfill Directive is divert biodegradable waste from landfill to reduce CH4 escaping to atmosphere.

The alleviation of GHG emissions from MSW must be addressed in the context of integrated waste management. Life Cycle Assessment (LCA) is an essential tool for consideration of both the direct and indirect impacts of waste management technologies and policies.

WRATE (Waste and Resources Assessment Tool for the Environment) is a LCA software tool for comparing different management systems treating MSW. This paper uses WRATE as an accepted base model. However, care has to be taken in the use of the tool and the interpretation of the results. The users have a responsibility to understand the processes and interpret the results correctly, so ambiguous information is not provided thus compromising the mitigation of GHG and climate change.

LCA - Comparison the environmental impacts between woodchip, pellet from firewood and pellet from “waste sawmill”

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1.Introduction

The paper describes the environmental impact assessment of wood pellet and wood chips production through a Life Cycle Analysis carried out using a detailed LCA software (Simapro6.0).

The Life Cycle Assessment (LCA) is a methodology of analysis finalized to appraise in the way most complete possible the environmental load of whichever activity. The life cycle of a product or a service is examined "from the cradle to the grave", through the compilation of an inventory of input (material, energy, natural resources) and output (issues in air, water, ground), the evaluation of potential, direct and indirect impacts., the analysis of the results and finally the definition of the possible lines of intervention to reduce its environmental impact. The maturity of the methodology is testified by the recent issue from the ISO (International Standards Organisation) of the relative normative technique (ISO14040-14044).

Methodology is used therefore to compare among them different technologies for the production of energy from biomasses.

The modern structure of the LCA is composed from four principal moments:

a. Goal definition and Scoping: an inventory step which entails identifying and quantifying the resources used (including energy, raw materials, and capital) and wastes and emissions generated at each phase of production;

b. Life Cycle Inventory (LCI): the first part of the job, devoted to the study of the life cycle of the process or activity. The principal purpose is to reconstruct the flow of the energy and of the materials;

c. Life Cycle Impact Assessment (LCIA): the study of the environmental impact provoked by the process or activity, that has the purpose to underline the entity of the modifications produced following the consumptions of resources and the releases in the environment calculated in the inventory;

d. Life Cycle Interpretation: the conclusive part of a LCA, that the purpose has to propose the necessary changes to reduce the environmental impact of the process or activity considered.

2. Application of the LCA to the production of pellet

Scope of this analysis is to appraise and to compare the environmental impacts of the production of pellet. Three energetic wood row are been compared: woodchips, pellet from firewood and pellet from “waste sawmill”. In the following figures the three row are represented.

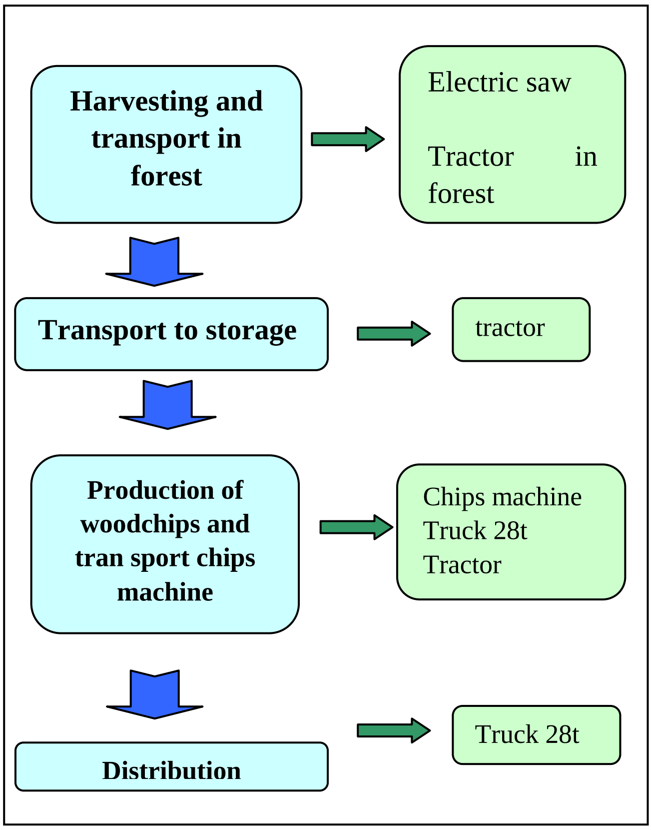

Figure 1 Energy row of woodchips

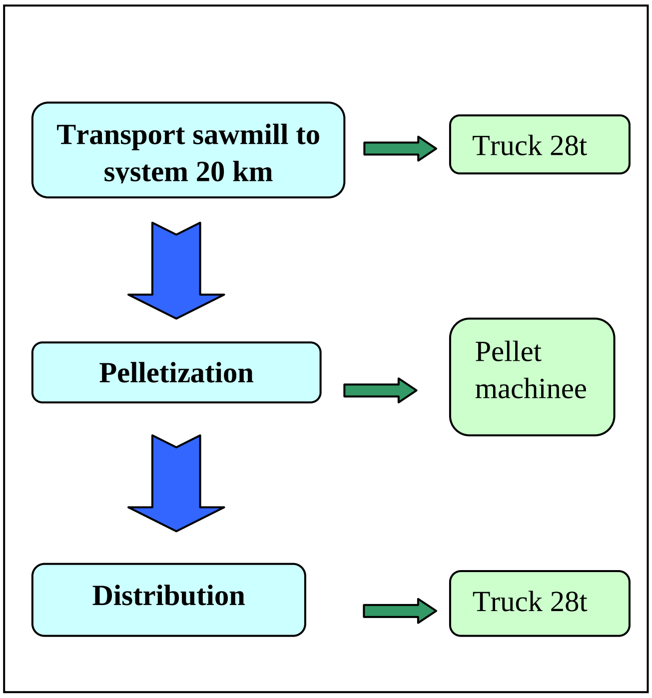

Figure 2 Energy row of pellet from waste of sawmill

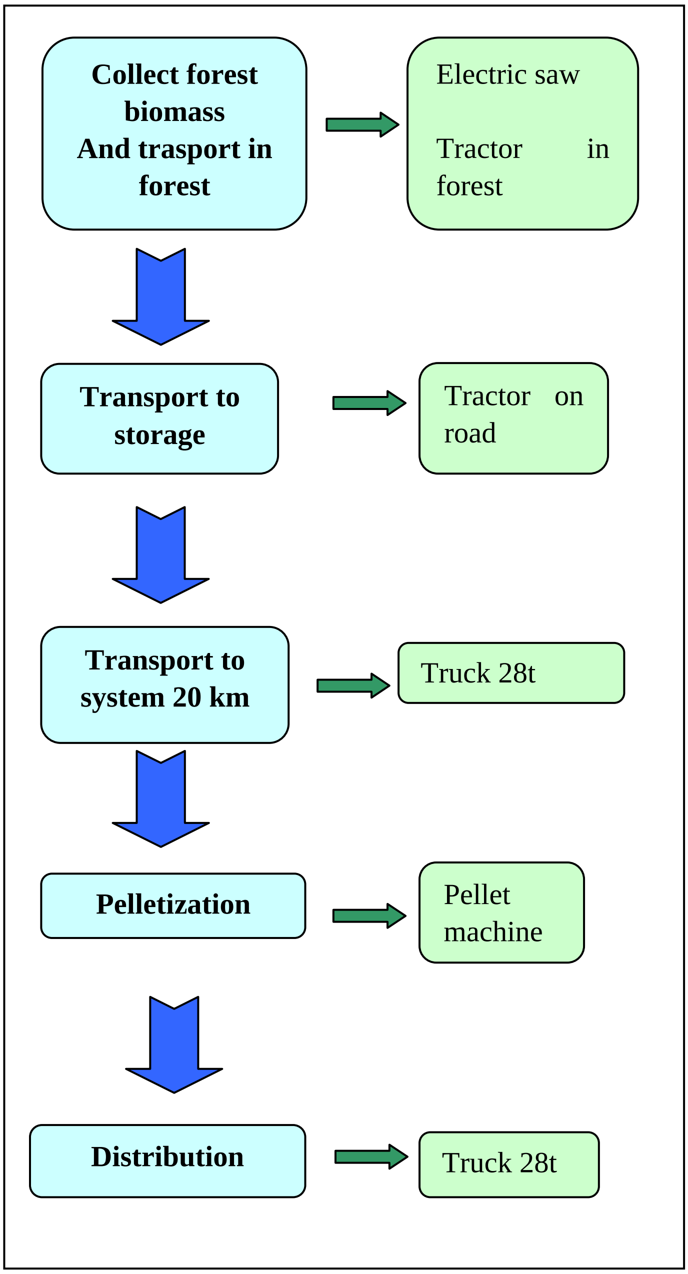

Figure 3 Energy row of pellet from firewood

3. Evaluation of environmental impact

The environmental impacts are analyzed and compared using 3 methods: Echo-indicator99, EDIP/UPIM96, Cumulaty Energy Demand (CED). In the following figures the environmental impacts are represented

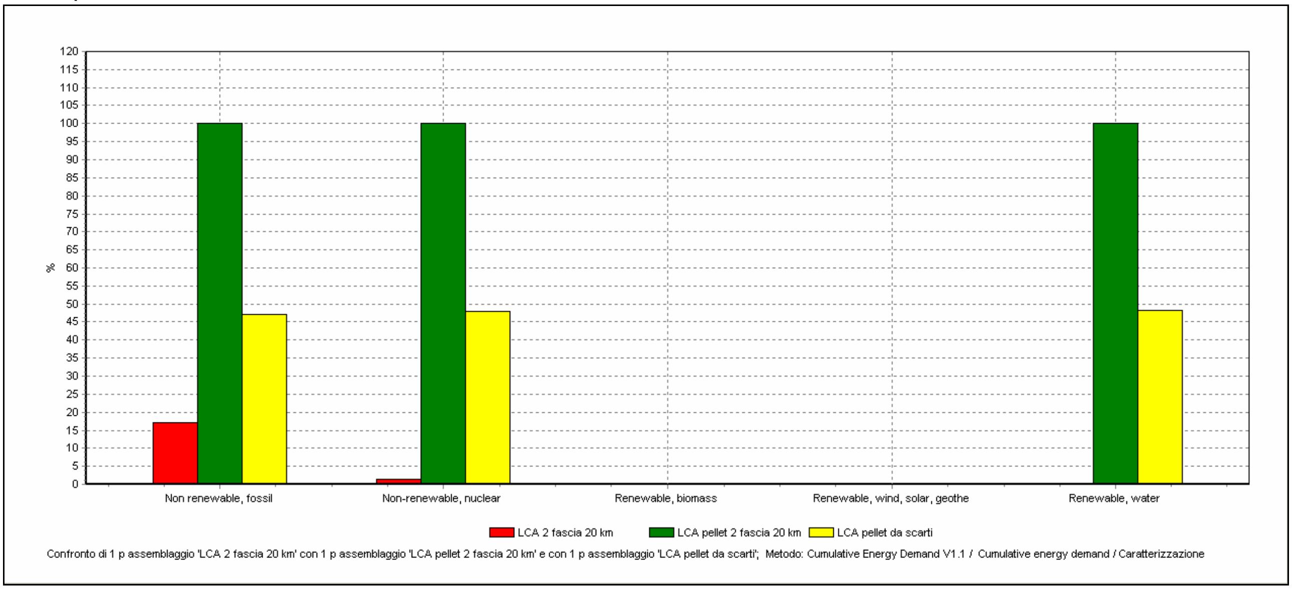

Figure 4 Method CED. Energy consumption

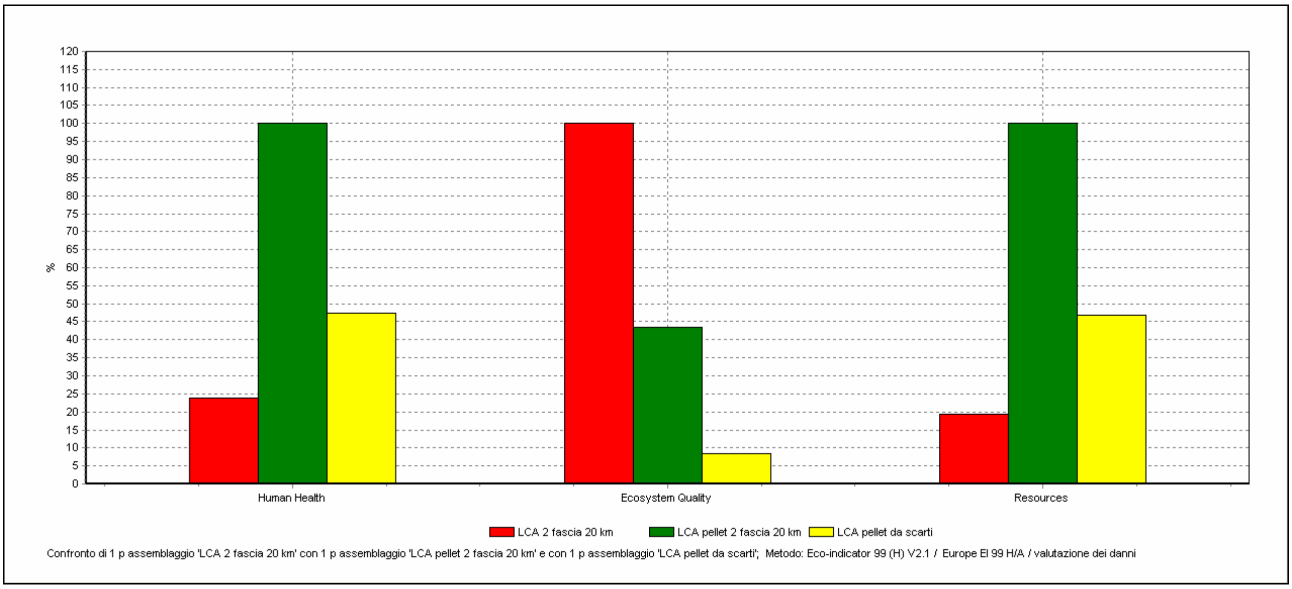

Figure 5 Ecoindicator99. Contribute to Human Health, Ecosystem Quality and Resources (red pellet from firewood, green pellet from waste of sawmill)

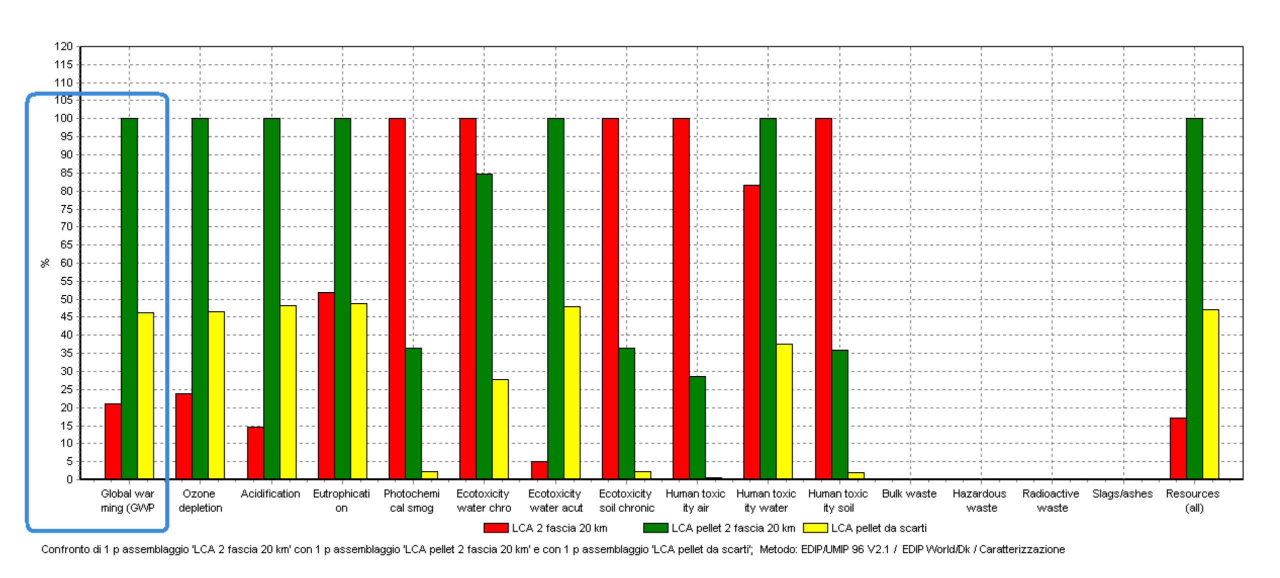

Figure 6. EDIP/UPIM96. Contribute to Global Warming (red- woodchips, green-pellet from firewood, yellow

4. Conclusion

The results of the Life Cycle Assessment show that the pellet from “sawmill waste” has less environmental impacts than pellet from firewood and has more environmental impacts than woodchips In order to reduced the impacts of both the rows of pellet and to obtain therefore little emissions, a pellet machine with little power or with a greater hour production can be used. In fact from the comparison we can be noticed that the consumption of the pelletization is smaller for pellet from “waste sawmill” than for pellet from firewood, because the hour production doubles and therefore the consumed energy is halved.

LCA of thermal treatment of waste streams in cement clinker kilns in Belgium – A comparison to alternative treatment options

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Selected topic: 6 Energy Balance of Emerging Technologies (using waste as fuel)

Abstract

On request of Febelcem, TNO performed a Life Cycle Assessment (LCA) on the environmental impact of the thermal processing of waste streams in the Belgian cement industry, compared with the thermal treatment in alternative treatment options (waste incinerators). Five waste streams were defined: solvents/waste oil, filter cake, sawdust impregnated paint/ink sludge, fluff and waste water treatment sludge. Based on differences in physical properties between the waste streams, it was decided to compare to specific treatment options for each specific waste stream: rotary kiln incineration (for the three first mentioned wastes) and fluidised bed combustion (for the letter two).
The functional unit was defined as the thermal treatment of one ton of specific waste in Belgium in 2006 (and ***not*** the production of one ton of cement clinker). In this way the two intrinsically different systems (cement clinker production and waste incineration) can be compared without large difficulties.

From the Belgian cement industry, all required 2006-based data were gathered, from which the required input was defined for application of the LCA CML method. All six cement kilns (on four locations) that use wastes as a secondary fuel were taken into account. The calculations are based on the method of marginal changes, which defines impact results to a certain base case. The base case is the mix of primary and secondary fuels in the cement industry in Belgium in 2006, and the marginal change is defined as the treatment of one extra ton of one of the five waste streams. In this study, the combustion of petroleum cokes is used as basic substitution for the use of secondary fuel in the cement industry. To a certain extent, the substitution of raw materials by ashes from the defined waste streams is incorporated, as result of the substitution of petroleum cokes.
The models for the alternative treatment options (incinerators) were defined based on reference processes, gathered from an Eco-invent study performed on a Swiss incineration plant, and the TNO specific knowledge. For this industry, the replacement of fossil electricity and heat is defined as the outcome of the process. As well as for the cement industry, waste streams are substituted based on the calorific value of the respective fuels.

Based on the results of this study, TNO safely concludes that, from an environmental point of view, the thermal treatment of the waste streams under regard in a cement kiln is in all cases favourable, compared to the most relevant alternative treatment options (incinerators). The minor negative impact in the pre-treatment of some of the waste streams is by far more than compensated for during the actual processing in the cement kilns. The largest positive effect of thermal treatment in cement kilns compared to the treatment in the incinerators is caused by the lower CO_2 emission at the stack, due to the different organic composition of the waste streams, compared to petroleum cokes. A second positive effect is the fact that cement kilns do not have emissions of toxic substances to water, whereas incinerator's rotary kilns do have such emissions.
Seven variables were subjected to a sensitivity analysis, to check the robustness of the conclusions. In most cases the difference in shadow prices between cement kilns on the one hand and waste incineration on the other hand decreased, but in no single case the conclusions changed. So, the conclusions can be said to be robust. The difference between wet and dry cement production processes proved to be only marginal.

Lifecycle assessment, carbon footprints, product journeys – trade-offs and balances

Jane Bickerstaffe
Director, INCPEN

INCPEN has commissioned and carried out many studies that measure the environmental impact of packaging and product supply systems. A summary of results of the studies and some general conclusions includes the following points :-

- **No material or type of packaging has a monopoly of environmental virtues.** Whether the packaging is degradable or inert, derived from renewable or non-renewable sources, capable of being refilled, easy or difficult to recycle is of secondary importance to the role it plays in protecting goods and thereby minimising waste of the goods throughout the entire product journey.

- **Consumers are unaware of the goods supply chain or the role played by packaging.** They first see packaging in the shops when it has come to almost the end of its useful life. Even then they seldom pay any conscious attention to it until it has been emptied or occasionally if it doesn't work properly or is difficult to open.

- **In the same way that consumers are aware only of the retail part of the supply chain, they also see only the municipal waste collection service and have no knowledge of the rest of the waste management and materials reprocessing system.** They do not know that collecting, transporting, cleaning used materials, recovering materials and energy, and disposing of residues all have an impact on the environment.

- **The waste management hierarchy is only a useful general guide on how waste should be handled.** It is not a guide for what materials should be used because that depends on a huge number of functional, environmental, social and economic variables, such as filling speeds on the production line, height of stacking in warehouses, materials, energy and water use, portion size, length of shelf life, consumers' needs, and best available method of recovering value at end of life.

- **We know how to manage solid waste.** The issue is how much money we want to spend on managing it to high standards. We do not know how to manage climate change so perhaps, in making trade-offs, we should favour those choices that help reduce emission of climate change gases above reducing waste.

Isn't it time we stopped trying to decide whether one type packaging is environmentally better or worse than another and focused on improving all of them? Similarly, shouldn't we stop trying to make the waste hierarchy rigid and focus instead on recovering materials and/or energy by all possible means?

Both the supply chain and local government and the waste management industry have a challenging task to explain the complexity of product journeys and lifecycles to the public and regulators. Working together could help all of us.

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BIOGRAPHY

Jane has been Director of INCPEN since 2000, having been its Technical Director since 1993. She trained as a biochemist and has over 20 years experience working on packaging and environmental issues. She spent two years in the late 1980s as Special Advisor to the UK Government's first Minister with responsibility for recycling. She is also a:

- Member of UK Government Advisory Committee on Waste and Resources R&D
- Fellow of the Royal Society of Arts
- Fellow of the Institute of Packaging
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A Life Cycle Assessment Tool for Construction of Asphalt Pavements

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Abstract

The increasing use of recycled materials in asphalt pavements calls for environmental assessment of such key impacts as the energy and CO_2 footprint. Life cycle assessment (LCA) is being accepted by the highway sector to measure these impacts. The ISO 14025 Type III Environmental Product Declaration (EPD), which enables the informed comparison between products that fulfil the same function, requires quantified environmental information based on independently verified LCA results.

This paper introduces the basics of LCA; reviews relevant LCA resources worldwide; identifies the knowledge gap for the highway sector; and describes the development of a LCA model for pavement construction and maintenance that accommodates recycling and up-to-date research findings. Details are provided of both the methodology and data acquisition. This is followed by a discussion of the benefits as well as challenges of applying LCA to the pavement construction practice, and recommendations for further work. The LCA model can be further developed to become a decision support tool for sustainable construction in the highway sector.

The model is applied to asphalt paving on an access road at London Heathrow Terminal-5, in which natural aggregates were replaced with waste glass, incinerator bottom ash, and recycled asphalt pavements. The production of hot mix asphalt and bitumen were found to represent the most energy intensive processes. Recycled asphalt planings were found to be the most desirable type of recycled aggregates reducing energy demand; while use of recycled glass caused more energy consumption and increased emissions. The analysis was followed by a sensitivity check.

Keywords: asphalt pavements; life cycle assessment; recycling; sustainable construction

Zero emissions systems in the food processing industry – to make zero emissions technologies and strategies become a reality

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Abstract

The food processing industry plays an important role in the economic development of every country. It is also a part of an interlinked group of sectors that can not lack in the development of economy. It, however, a strongly growing food processing industry greatly magnifies the problems of waste management, pushing the management of waste and pollution level to the forefront of environmental challenges. While concepts to minimize, reuse and recycle wastes proposed have not solved thoroughly the negative effects on environment and human population, zero emissions concepts have arisen. It implies the optimization through an integrated system of processes and requires the industries to redesign manufacturing processes to efficiently use both raw material within the process and waste towards the aim of sustainability. It means that utilization of waste can be brought back to at sustainable levels in closed loop processes, bearing the phenomenon of industrial metabolism.

This paper starts with an outline of the concepts of zero emissions technologies and strategies, and continues with an overview of the possibilities to apply these concepts. Following this, a zero emissions agricultural industrial system model for the food processing industry will be displayed, emphasizing on the utilization of all food wastes as inputs in an anaerobic digestion process. The model permits an identification of opportunities for reducing environmental impact at process level and driving the system toward sustainability and zero emissions concepts. It also describes the possibilities to make zero emissions technologies become a reality. Case study, focusing on the Pineapple processing industry, will be used to illustrate the application of the aggregated material input-output model. The case study will also represent energy and material balances, inputs and outputs as well as calculations on the economic feasibility of model of zero emissions agro-based system. The research can lay out a promising path to adapt to environmentally friendly issues through alternative use of fossil fuels, chemical fertilizers, and reducing greenhouse effect gases.

Key-words*:* Anaerobic digestion, zero emissions system, pineapple waste, food processing industry.