“**The Interpretation of Life Cycle Thinking in the Waste Management Hierarchy**”

Report based on the ACR+ International Experts Seminar

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ALL PRESENTATIONS FROM THE INTERNATIONAL EXPERTS SEMINAR ARE AVAILABLE ON THE ACR+ WEBSITE: http://www.acrplus.org/ seminar_life_cycle_thinking

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Glossary

Alternative fuels and raw materials (AFR): Inputs to clinker production derived from waste streams that contribute energy and/or raw material.

Alternative fuels: Wastes with recoverable energy value used as fuels in a cement kiln, replacing a portion of conventional fossil fuels, like coal. These are sometimes termed secondary, substitute or waste-derived fuels, among others.

Alternative raw materials: Wastes containing useful minerals such as calcium, silica, alumina, and iron used as raw materials in the kiln, replacing raw materials such as clay, shale, and limestone. These are sometimes termed secondary or substitute raw materials.

Best available techniques (BAT): The most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole.

Cement kiln dust (CKD): The fine-grained, solid, highly alkaline material removed from cement kiln exhaust gas by air pollution control devices. Much of the material comprising CKD is actually unreacted raw material, including raw mix at various stages of burning and particles of clinker. The term CKD is sometimes used to denote all dust from cement kilns, i.e. also from bypass systems.

Cement: Finely ground inorganic material which, when mixed with water, forms a paste which sets and hardens by means of hydration reactions and processes and which, after hardening, retains its strength and stability under water.

Clinkering: The thermochemical formation of the actual clinker minerals, especially to those reactions occurring above about 1300°C; also the zone in the kiln where this occurs. Also known as sintering or burning.

Co-Incineration plant: Under Directive 2000/76/EC of the European Parliament and of the Council, any stationary or mobile plant whose main purpose is the generation of energy or production of material products and which uses wastes as a regular or additional fuel; or in which waste is thermally treated for the purpose of disposal. If co-incineration takes place in such a way that the main purpose of the plant is not the generation of energy or production of material products but rather the thermal treatment of waste, the plant shall be regarded as an incineration plant.

Concrete: Building material made by mixing a cementing material (such as Portland cement) along with aggregate (such as sand and gravel) with sufficient water and additives to cause the cement to set and bind the entire mass.

Conventional (fossil) fuels: Non-renewable carbon-based fuels traditionally used in cement manufacturing, including coal and oil.

Co-processing: The use of suitable waste materials in manufacturing processes for the purpose of energy and/or resource recovery and resultant reduction in the use of conventional fuels and/or raw materials through substitution.

Dry process: Process technology for cement production. In the dry process, the raw materials enter the cement kiln in a dry condition after being ground to a fine powder (raw meal). The dry process is less energy consuming than the wet process, where water is added to the raw materials during grinding to form a slurry.

Environmental impact assessment (EIA): An examination, analysis and assessment of planned activities with a view to ensuring environmentally sound and sustainable development. Criteria for determining the requirement for an EIA should be clearly defined in legal/policy sources.

Heating (calorific) value: The heat per unit mass produced by complete combustion of a given substance. Calorific values are used to express the energy values of fuels; usually these are expressed in megajoules per kilogram (MJ/kg).

Kiln line: The part of the cement plant that manufactures clinker; comprises the kiln itself plus any preheaters and precalciners, plus the clinker cooler apparatus.

Kiln: The heating apparatus in a cement plant in which clinker is manufactured. Unless otherwise specified, may be assumed to refer to a rotary kiln.

Life Cycle Assessment (LCA): objective process to evaluate the environmental burdens/benefits associated with a product, process or activity by identifying and quantifying energy and materials used and wastes released to the environment, to assess the impact of those energy and materials uses and releases to the environment, and to evaluate and implement opportunities to affect environmental improvements. The assessment includes the entire life cycle of the product, process or activity, encompassing extracting and processing raw materials; manufacturing, transportation and distribution; use, reuse and maintenance; recycling and final disposal (Source: Article 4.2 of the Waste Framework Directive 2008/98)

Municipal Solid Waste (MSW): Waste originating from households, commerce and trade, small businesses, office buildings, institutions and from selected municipal services, (waste from parks and garden maintenance and street cleaning services); collected by or on behalf of municipalities. Waste from the same sources and similar in nature and composition collected by the private sector and waste from rural areas not served by a regular waste service.

Operator: Any natural or legal person who operates or controls the installation or facility.

Quality assurance (QA): A system of management activities involving planning, implementation, assessment, and reporting to make sure that the end product (for example, environmental data) is of the type and quality needed to meet the needs of the user.

Quality control (QC): Overall system of operational techniques and activities that are used to fulfill requirements for quality.

Raw mix/meal/feed: The crushed, ground, proportioned, and thoroughly mixed raw material-feed to the kiln line.

Recovery: Any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfill a particular function, or waste being prepared to fulfill that function, in the plant or in the wider economy.

Waste (management) hierarchy: List of waste management strategies arranged in order of preference, with waste prevention being the most desirable option and disposal the least preferred approach. Departing from such hierarchy may be necessary for specific waste streams when justified for reasons of, inter alia, technical feasibility, economic viability and environmental protection. (Source: Article 4 of the Waste Framework Directive 2008/98)

Abbreviations and Acronyms

ACR+	Association of Cities and Regions for Recycling and Sustainable Resource Management
BAT	Best Available Technique
BREF	Reference Document on Best Available Techniques (as published by the EIPPCB, http://eippcb.jrc.es/)
CBA	Cost Benefit Analysis
CEM	Continuous Emission Monitoring Systems
CEN	European Committee for Standardization (http://www.cen.eu/)
CKD	Cement Kiln Dust
COP	Conference of the parties
EIPPCB	European Integrated Pollution Prevention Control Bureau (http://eippcb.jrc.es/)
EU	European Union
JRC	Joint Research Center
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LCT	Life Cycle Thinking
LGR	Low Grade Resources
MSW	Municipal Solid Waste
NGO	Non Governmental Organization
OECD	Organisation for Economic Co-operation and Development (http://www.oecd.org/)
PCB	Polychlorinated Biphenyl
POP	Persistent Organic Pollutant
QA	Quality Assurance
QC	Quality Control
S-LCA	Social Life Cycle Assessment
UNEP	United Nations Environment Programme (http://www.unep.org/)
VOC	Volatile Organic Compound

1. Introduction

This expert's seminar was organized in the framework of a partnership between ACR+ and Holcim (www.holcim.com). This partnership aims at feeding the debate and identifying the best practices in link with the optimal management of resources in the context of waste management policies. It intends to explore legal and technical solutions in link with multiple policy developments at international level, namely:

- at UN level: United Nations Environment Program (UNEP) / Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, Conference of the Parties (COP) Climate Change.
- at EU level: new Waste Framework Directive, Post-Lisbon developments, EU 2020 objectives, new EU Framework Programme for the Environment and revision of several EU Strategies and the upcoming **Roadmap to a Resource Efficient Europe**

1.1. Objectives and format of the seminar

This Seminar is the third of its kind within the ACR+/Holcim Group partnership, following the ones in Turin[1] (December 2009) and Seville[2] (June 2010). It took place in Brussels and focused on the new European waste policy and the implementation of the waste hierarchy in relationship with the concept of "Life Cycle Thinking".

It gathered a group of nearly sixty experts in order to discuss concrete examples of the interpretation of the EU waste hierarchy through Life Cycle Thinking, as foreseen in article 14.2 of the Waste Framework Directive 2008/98. The Seminar was followed by two site visits: to an anaerobic digestion plant in Sequedin (Lille Métropole, France) and to a pre-processing plant (Geocycle in Seneffe, Belgium), in order to complement the theoretical and legislator considerations (cf. Appendix 4).

[1] www.acrplus.org/default.aspx?page=545&editview=true
[2] www.acrplus.org/Seminar-Sevilla-2010

This report aims to present the issues touched upon during the Seminar, as well as its outcomes and conclusions.

1.2. EU Waste Policy and Vision

The Waste Framework Directive 2008/98 foresees in its article 4 a legal EU five stage waste hierarchy [3] providing clear priorities to the decision-makers when it comes to manage waste.

The following waste hierarchy shall apply as a priority order in waste prevention and management legislation and policy:

(a) prevention;

(b) preparing for re-use;

(c) recycling;

(d) other recovery, e.g. energy recovery; and

(e) disposal.

In the same article (§ 2) it states that “when applying the waste hierarchy referred to in paragraph 1, Member States shall take measures to encourage the options that deliver the best overall environmental outcome. This may require specific waste streams departing from the hierarchy where this is justified by life-cycle thinking on the overall impacts of the generation and management of such waste.

In addition, the new EU recycling targets (Appendix 1) are putting more pressure on EU member states to improve the separate collection of materials for recycling and re-processing or recovery.

[3] Waste Management Hierarchy: EU Directive 2008/98/EC Waste

In order to comply with the objectives of the Waste Framework Directive (Art. 11.2), and move towards a **European Recycling Society**[4] with a high level of resource efficiency, Member States shall follow strictly the waste hierarchy and take the necessary measures designed to achieve the following targets:
(a) by 2020, the preparing for re-use and the recycling of waste materials such as at least paper, metal, plastic and glass from households and possibly from other origins as far as these waste streams are similar to waste from households, shall be increased to a **minimum of overall 50% by weight;**
(b) by 2020, the preparing for re-use, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste excluding naturally occurring material shall be increased to a **minimum of 70% by weight;**

Following a top down approach of the waste hierarchy it is interesting to identify the level of waste hierarchy where co-processing can be applied, in comparison (or in complement) to recycling, energy recovery and disposal.

1.3. Waste and Life Cycle Thinking

Jean-Pierre Hannequart, president of ACR+, as the first speaker at the conference, presented the various approaches of LCT/ LCA and its link to the waste hierarchy. Life Cycle Thinking (LCT) is a guiding principle to shape production and consumption strategies which takes into account all environmental, economic and social impacts that a product / service will have throughout its life cycle (from the extraction of raw materials to production, distribution and consumption to end of life – see Figure 1 below). The key aim of Life Cycle Thinking is to avoid burden-shifting. This

[4] European Recycling Society: EU as a recycling society - Present recycling levels of Municipal Waste and Construction & Demolition Waste in the EU", ETC/SCP April 2009

means minimising impacts at one stage of the life cycle, or in a geographic region, or in a particular impact category, while helping to avoid increases elsewhere[5].

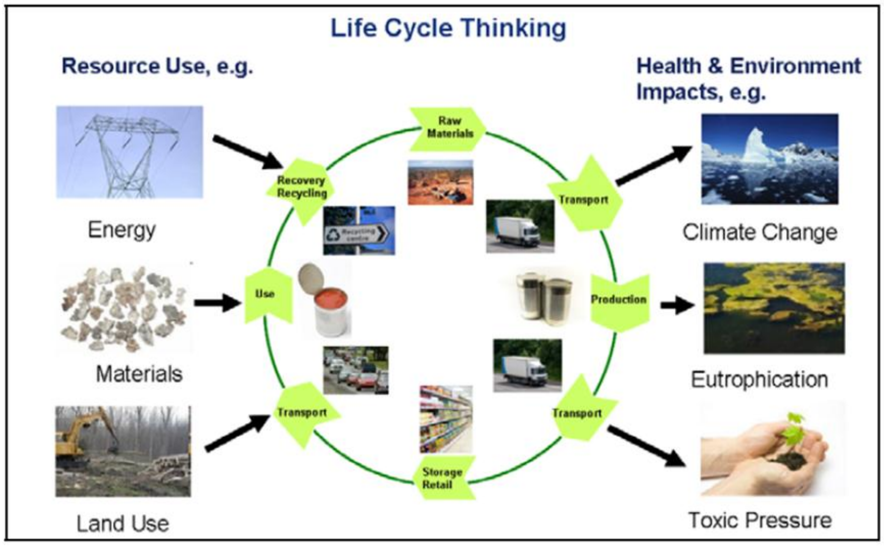

Figure 1: Elements within Life Cycle Thinking.

The Waste Framework Directive 2008/98/EC establishes a priority order in waste prevention and management as follows:

1) prevention;
2) preparing for re-use;
3) recycling;
4) other recovery (e.g. energy recovery);
5) disposal.

Obviously, step 1 is supposed to be considered before step 2, step 2 before step 3 and so on.....

> *"Article 4 of the Waste Framework Directive (WFD) defines the application of the waste hierarchy as follows: when applying the waste hierarchy referred to in paragraph 1, Member States shall take measures to encourage the options that deliver the best overall environmental outcome. This may require specific waste streams departing from the hierarchy where this is justified by life-cycle thinking on the overall impacts of the generation and management of such waste".*

[5] After *Our Thinking, Life Cycle Thinking* from Life Cycle Website (www.lct.jrc.ec.europa.eu), European Commission.

“LCT can and should be applied to waste management as an essential complement to the waste hierarchy, in view of its ability to integrate all the variables that influence the environmental performance” (EC).

Under the conceptual framework defined by LCT, a number of quantitative decision support methods exist, such as Life Cycle Assessment (LCA), Cost-Benefit Analysis (CBA), Life Cycle Costing (LCC or the economic implications of LCT) and Social LCA (S-LCA or the social impacts on people in the life cycle of the product).

Life Cycle Thinking can be quantified through Life Cycle Assessment (LCA). LCA is a tool used to evaluate the potential environmental impacts of a product, process or activity throughout its entire life cycle, by quantifying ecological and human health impacts. In other words, according to the EC report on Waste Thematic Strategy, LCA is a tool, standardised in ISO14040/44, which quantitatively supports life-cycle thinking.

According to ISO 14040, LCA can be defined as a systematic set of procedures for compiling and examining the inputs and outputs of materials and energy and the associated environmental impacts directly attributable to the functioning of a product or service system throughout its life. LCA thus quantifies and assesses the emissions, resources consumed, and pressures on health and the environment that can be attributed to products or services over their entire life cycle. It seeks to quantify all physical exchanges with the environment including inputs in the form of natural resources, land use and energy, or outputs in the form of emissions to air, water and soil. These inputs and outputs associated with a product’s life cycle are put together in a “balance sheet”, or life cycle “inventory”[6].

<u>There are four linked components of LCA:</u>

- Goal definition and scoping: identifying its purpose, its boundaries (what is and what is not included in a study) and its assumptions;
- Life-cycle inventory: quantifying the energy and raw material inputs and emissions in each production stage;

[6] [6] After European Commission, *Making Sustainable Consumption and Production a Reality. A guide for business and policy makers to Life Cycle Thinking and Assessment.* Luxembourg: Publications Office of the European Union, 2010

- Impact analysis: assessing the impacts on human health and the environment;
- Improvement analysis: evaluating opportunities to reduce energy, material inputs and, impacts on human health and environment.

In practice, LCT can actually help to evaluate and rank possible waste treatment options:

> "In some cases, a number of alternatives exist at a given level of the waste hierarchy (e.g. different recycling alternatives for a given waste stream). These alternatives may not be equivalent from an environmental perspective. A scientifically sound approach to ensure that the best outcome for the environment can be identified is provided by Life Cycle Thinking" (Draft Guidance on Interpretation).

To illustrate this quote, let us consider an example of a ranking of possible sewage sludge treatment options basing on LCA (see Figure 2 below). Taking into account the CO_2 balance criteria, one can easily conclude that landfill is the worst option here, while co-processing in a cement kiln is the best one. Having considered the energy balance criteria, one realises that wet oxidation is the least beneficial option, while agricultural spreading and incineration are the most favourable ones.

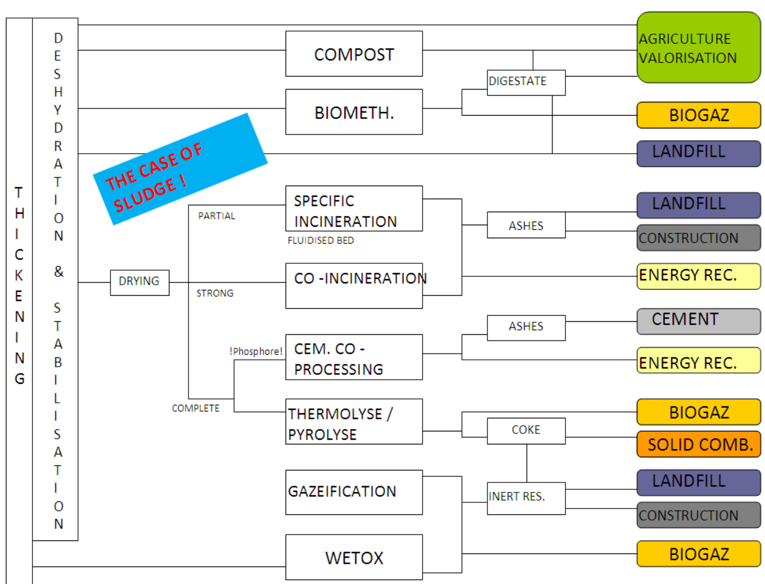

Figure 2: Evaluation of sludge treatment options on the basis of LCA.

Crucially, one should not forget that, even though LCT can be further developed using a number of quantitative tools, none of them are binding. Thus, LCT can be of help while establishing a ranking of a specific / combined waste treatment

2. Co-processing in Resource Intensive Industrial Processes

2.1. LCA applied for co-processing

Jean-Pierre Degré, Senior Vice President for Alternative Resources at Holcim Group, discussed the possibilities of a practical application of LCA in waste management. He stressed that current waste management practices leave a substantial part of the resource potential of waste unused (see Figure 3 below). According to his presentation:

> "Estimates indicate that worldwide up to 8.5 billion tonnes of waste are discarded each year. Despite all the efforts to minimize waste, more than 80% is currently landfilled, dumped or burned illegally, contributing to pollution and not being accessible for resources intensive industries" (Jean-Pierre Degré).

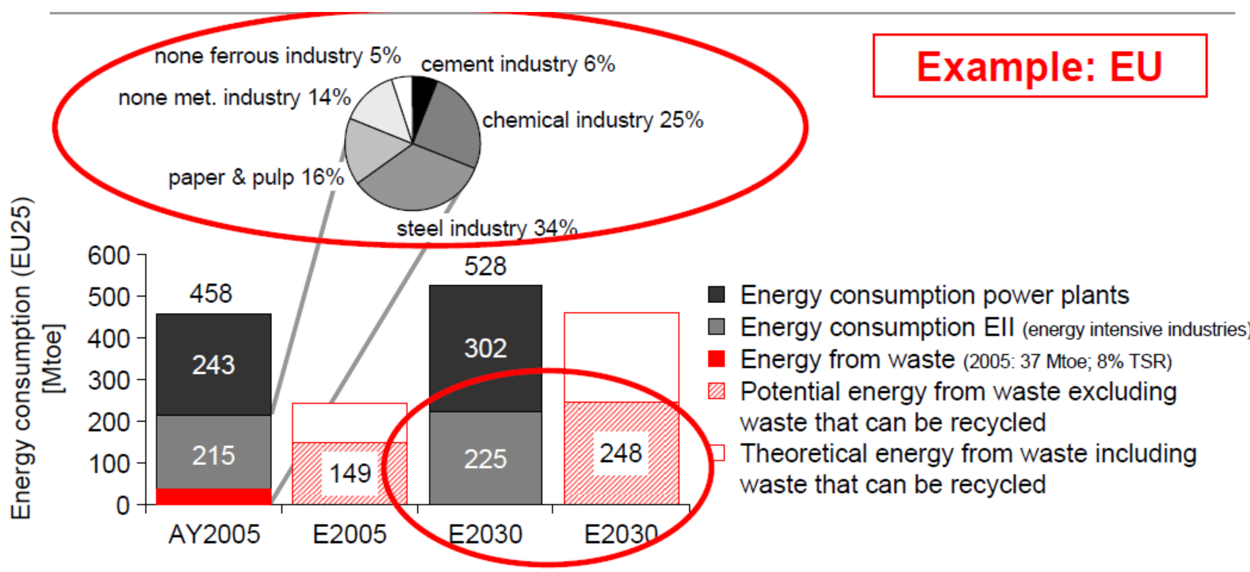

Figure 3: Potential energy recovery possibilities.

It is thus vital to look for alternative methods of protecting the environment and improving industry ecological footprint at the same time. The method proposed and promoted by Holcim is co-processing, or the use of waste as raw material or energy source in RII (Resource Intensive Industrial processes) to replace natural mineral resources (material recycling) and fossil fuels such as coal, petroleum and gas.

Applied locally, co-processing has several benefits:

- it upgrades waste management within the waste hierarchy;
- it reduces waste's health and environmental impacts;
- it maintains and improves the industrial sector's competitiveness;
- it largely decreases the costs of waste management;
- it improves all human and technical-economical factors.

Practical application

Taking all this into account, Holcim Group, an international cement producer, has modified the waste management hierarchy for their purposes, including co-processing as one of the steps in the hierarchy, namely before incineration and landfill (see Figure 4 below).

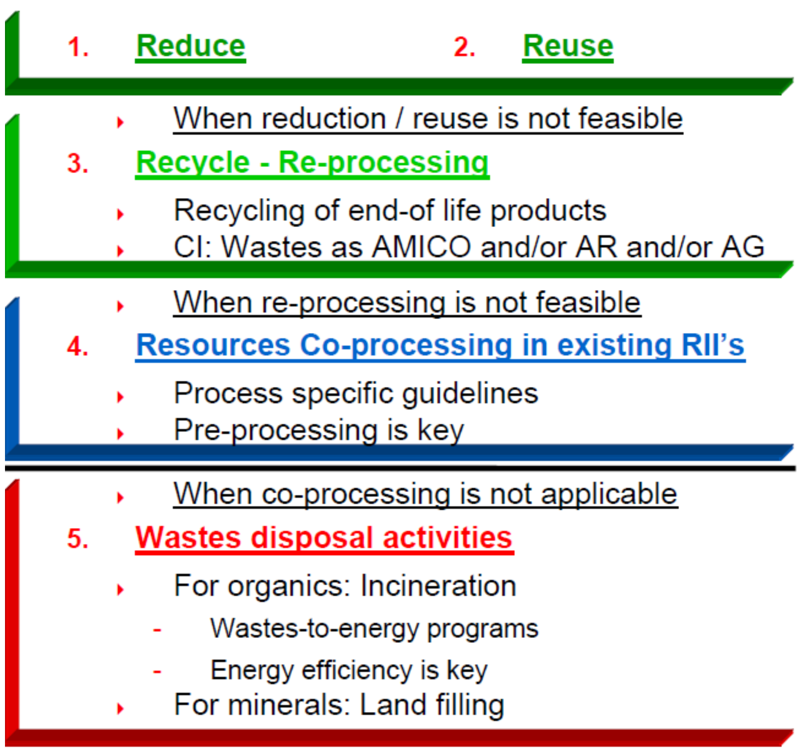

Figure 4: Holcim vision of waste management hierarchy.

As a result of these theoretical considerations, the Geocycle brand was created. It specialises in the recovery of waste through co-processing in the cement industry and is present in 42 countries.

It is interesting to note that waste volumes co-processed in the last five years surpass 30 million tonnes, while the waste portfolio is rather varied, ranging from diaper trimmings to rubber waste to used oil and grease (see Figure 5 below).

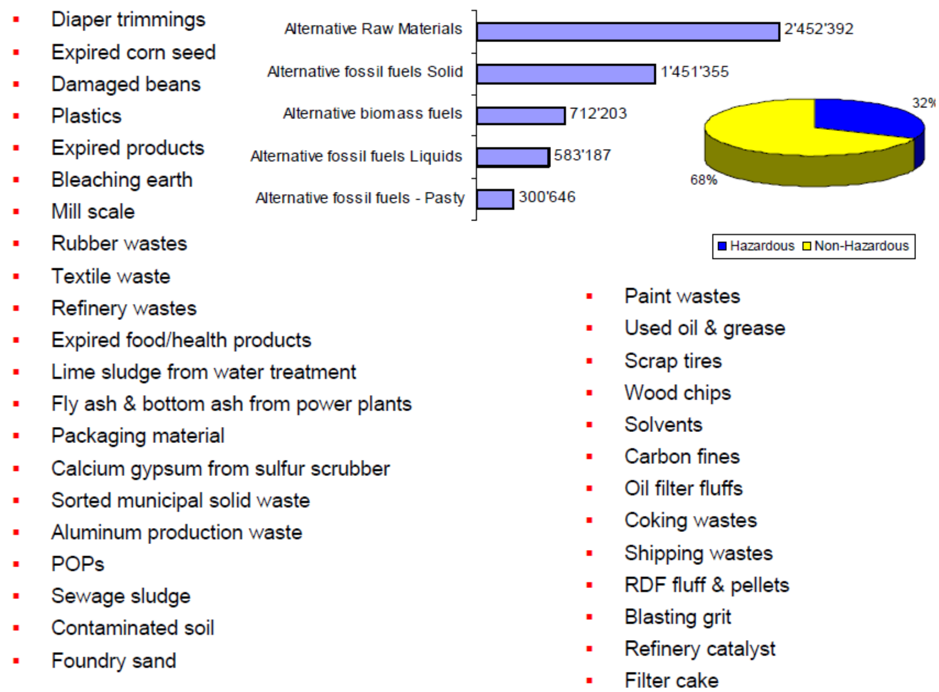

Figure 5: Waste portfolio: pre- and co-processed in 2010.

Legal framework

Nevertheless, no specific legal framework has yet been established for the concept of co-processing in Europe. Having said that, it is important to mention that several strategic partnerships and studies have been undertaken, in order to implement legal frames for co-processing. The above mentioned partnerships and studies include:

- a strategic alliance between Holcim and Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (GTZ) (2003 – 2009), which resulted in the publication of international guidelines for co-processing of waste materials in the cement production[7] (the

[7] Guidelines on co-processing Waste Materials in Cement Production:
http://www.holcim.com/gc/CORP/uploads/GuidelinesCOPROCEM_web.pdf

latter are being implemented in several countries, such as Mexico, China, South Africa and more);

- a study by Joachim Lohse providing recommendation for legal recognition of co-processing;
- co-processing has also been officially recognized by the European Commission as a resource efficient best practice under the Europe 2020 strategy (EU publication from 26 January 2011);
- it is also advocated by Cembureau (the European Cement Association) and EU cement industry;
- in India, the concept of co-processing has been extended to other RIIs.

Moreover, co-processing is also on its way to being granted a UN legal framework. It was presented during the Basel Convention[8] COP 9 back in 2008, and soon after Chile volunteered to draft Technical Guidelines for Co-processing of Hazardous Waste in Cement Kilns (cf. Section 3). The latest draft was published in March 2011 and will consequently be presented at the Basel Convention COP 10 in October 2011.

Future challenges

As a future challenge, Holcim proposes to include different types of LGR as well as different waste flows in their end-product portfolio in the following way:

[8] The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, in force since 1992, is the most comprehensive global environmental agreement on hazardous and other wastes. The Convention has 175 Parties and aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes.
The Basel Convention establishes that signatory countries must put in place an environmentally sound hazardous waste management system, where waste prevention and recovery constitute the preeminent principles of this strategy. Where waste generation avoidance is not possible, reuse, recycling and recovery become, in many cases, an alternative preferable to final disposal.

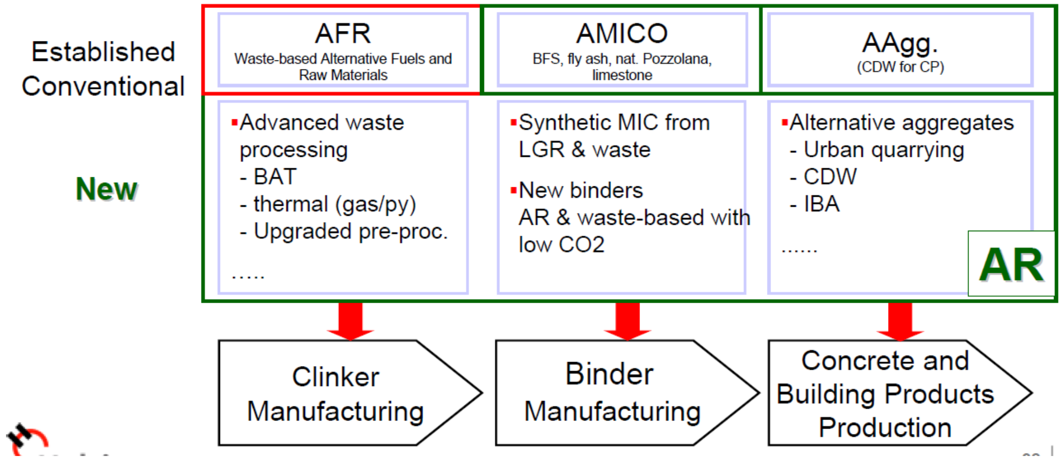

Figure 6: Holcim value chain offers opportunities to integrate many types of LGR and waste.

Finally, it is also considered that there is a need for mandatory LCA for cement producers and other RIIs to use waste and low-grade resources. Theoretically, there is also a possibility to produce cementitious binder at 0 % clinker and from 100 % W/LGR management – in practice, major hurdles will need to be overcome. At the same time, it is vital to work together with NGOs and target the cement industry for a significant CO_2 reduction per tonne of end product.

2.2. Towards international recognition and rules for co-processing

As it has already been said in Section 2, co-processing of waste in the resource-intensive industries can be an important element in a sustainable system of managing raw materials and energy. Such waste management solution brings positive impacts, both financial and environmental. However, crucially, a suitable management ensuring that no new externalities arise in such processes is required. In order to guarantee an international basis for co-processing management, technical guidelines validated by the Basel Convention and the United Nations are needed for the acceptance and the good practice of co-processing.

Andrés Jensen, Chilean Public-Private Task Force Member, explained the involvement of Chile in the process of establishing the above mentioned technical guidelines. In December 2008, thanks to the experience in the domains of energy and/or material recovery from waste in cement kilns, Chile was entrusted the mission of developing "Technical Guidelines for Co-processing of Hazardous Waste in Cement Kilns" by the Basel Convention Executive Secretariat.

In order to tackle this challenge, a Public/Private Workgroup was formed, led by the Chilean Department of Health and comprised of the Department of Environment and Coprocem (co-processing units of three Chilean cement companies, namely, Cemento Polpaico, Cementos Bío Bío and Cementos Melón (cf. Figure 7 below).

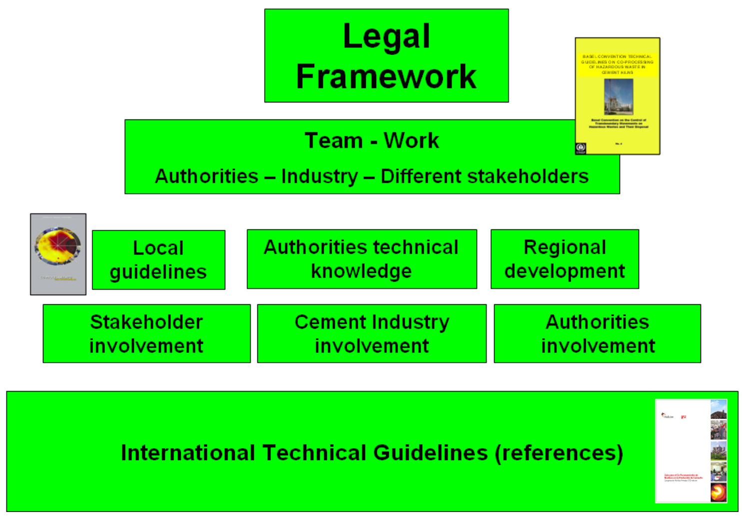

Figure 7: Capacity building - from Public/Private Workgroup to a legal framework.

Once the necessary data were gathered, a dialogue was established with different stakeholders (authorities, academic world, communities and NGOs). In December 2009, Chile proposed the first draft of the "Technical Guidelines" to the Basel Convention Executive Secretariat and, consequently, received feedback from Canada, Mexico, Costa Rica, the EU, Cembureau and IPEN (International POPs Elimination Network). The draft was also discussed by more than 120 countries in Geneva, Switzerland, in May 2010.

Chile finally submitted the last draft to the Basel Convention Executive Secretariat on 31 March 2011[9]. It will now be translated into the 6 official languages of United Nations, and then submitted for consideration to the Conference of the Parties of the Basel Convention, for possible adoption and formalization. This will take place in Cartagena de Indias, Colombia, in October 2011.

[9] It is available at http://www.basel.int/techmatters.

It goes without saying that such a document is crucial for the consolidation of co-processing in developing countries, as it will validate this technology as a recovery option and act in favour of its acceptance. Finally, the public/private work led by the Ministry of Health also considers formalizing specific directives for co-processing at the national level. For this purpose, a local version of the guidelines is being developed.

3. How to address waste management issues with LCT

This Section of the report presents several approaches to dealing with waste management issues with the use of LCT and LCA. Firstly, it focuses on the possibilities LCT gives to local authorities. Then, it goes on to discuss the concept of ecological footprint and its relation to LCT. This is followed by a case study on mixed waste plastics. Finally, the Section ends with a presentation of a Spanish tool which allows to calculate environmental impacts of waste management.

3.1. Life Cycle Thinking for Local Authorities

"Life cycle thinking can be applied by local authorities in their programs for sustainable procurement, or by taking total costs of ownership into account" - Mr. Cok van Bergen Henegouw of Maastricht University and HVC groep Alkmaar presented on the possibilities of the use of LCA by local authorities in the framework of waste management.

Developments in LCA

The developments of dedicated LCA waste models started in the nineties. LCA tools were developed in almost every country. The differences between these tools are in the used data (recent or not), the scientific justification and credibility, the update options, the level of simplification, the flexibility in the choice of defaults or user-editable parameters, the possibility in variable input of waste composition, the user friendliness, the transparency and finally the price. Important inputs in LCA models for MSW (municipal solid waste) management systems are the national energy mix and waste amounts and composition (up to the chemical components of waste streams). This makes a good and complete LCA model for solid waste systems expensive tools. A workshop held in 2008 in Denmark revealed that the different LCA models for a particular MSW management system give different results when using similar data. Even though current LCA models still tend to be country-specific, the outcomes of several LCA models show that the environmental impact of waste management is lowered when recycling rates are increasing and/or when the energy efficiency of waste-to-energy plants is improving.

LCT for local authorities

Local authorities can use LCT in tendering processes for products by taking the lifetime and subsequent additional maintenance into account ("total cost of ownership"), recycle percentage of end-of-life products and the percentage of used recycled material in new products. In this way, local authorities can influence product design in general and eco-design in particular. It is clear, however, that the sustainability criteria for these procurement processes should be agreed upon on a national and European level.

LCT is more complicated for local authorities with regard to service systems, such as MSW systems, which, in turn, are subject to the European Waste Hierarchy (cf. Section 1). Consequently, in line with the Waste Hierarchy, the focus of local authorities should be on the minimization of mixed waste, as the latter can only be incinerated and/of landfilled and these are the lowest steps in the hierarchy. Mixed waste reduction can be done by stimulating prevention (although it is impossible to measure the effects of waste prevention actions), reuse (by facilitating second-hand and repair shops) and recycling (by rewarding households for good recycling behaviour or integrating sorting facilities for mixed waste).

A practical example

An interesting example regarding recycling stimulation can be found in the Netherlands and Flanders (see Figure 8 below). Namely, in the Netherlands the recycling rate of household waste increased between 1995 and 2010 from 42% to 49%, while in Flanders it went up from 33% in 1995 to 73% in 2010. The difference in waste management policy between the two countries was that in Flanders a financial incentive was introduced and the service level for households was increased towards recyclables. This policy was imposed on the local authorities through contracts that connected mixed waste minimization results and financial consequence, together with specific subsidies for investments to stimulate recycling.

In the Netherlands, on the other hand, the policy to stimulate recycling was also introduced on a national level by mentioning recycling targets, but it was left to the municipalities to implement them. No enforcement or penalties were introduced for municipalities who did not reach the targets. At present, only 36% of the municipalities in the Netherlands have introduced a financial incentive for households. This example illustrates the importance of good vertical governance in order to reach national or European objectives.

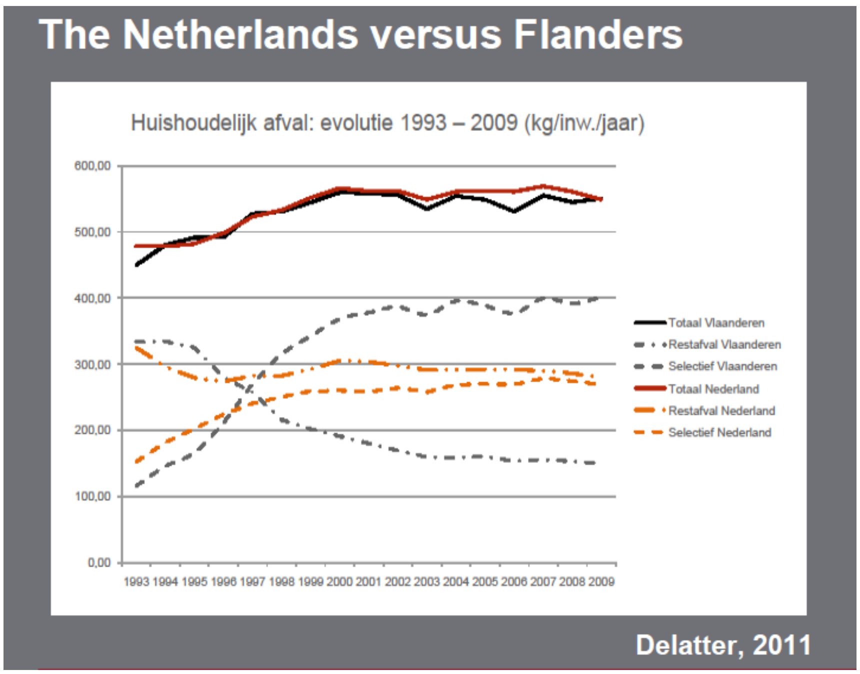

Figure 8: Recycling stimulation in the Netherlands and Flanders.

In conclusion, local authorities should do everything within their power to contribute to minimizing the environmental impact of waste management. An important tool here is the regulations laid down in the public procurement process where, next to the costs, reduction of the environmental impact should be the leading indicator. More importantly still, national and European authorities can play an important role by translating policy objectives to practical measures to be implemented by local authorities for households. Finally, if Europe and national governments want to use LCA as a tool (also for local authorities to assess future developments) this tool should be made more accessible and standardized.

3.2. Ecological footprint of organic waste management

The waste management industry is characterized by a multiplicity of waste streams and treatment solutions, which clearly leads to the frequent and legitimate question: which option is the best? Unfortunately, a definite answer to this question is not possible, as it depends on the waste stream, operation of the treatment facilities or opportunities to recover material, as well as energy produced from waste. Ms Alexandra Lalet of SITA France provided an example of a methodology to assess the ecological footprint of organic waste management.

Ecological footprint

The Ecological Footprint is defined as the surface of land and water biologically productive that a human population or activity requires to produce the resources it consumes and to absorb its wastes. Born in the early nineties from research work of two scientists - Mathis Wackernagel and William Rees - the Ecological Footprint was built to answer two questions: how much resource can nature provide and how much is humanity consuming? In short, the concept of ecological footprint refers to a means of assessing the human pressure on the biosphere and is measured by global hectare a year (gha.an).

SITA France

In 2005, SITA France decided to apply the Ecological Footprint indicator to its activities, through the "Waste Ecological Footprint" programme. To complete this project, an original partnership was set up with the Global Footprint Network, Médiation & Environnement, the Angénius Institute research structures and French municipalities. This led to the establishing of calculation tools, enabling one to assess the Ecological Footprint of waste treatment and recovery activities, such as composting, anaerobic digestion and mechanical biological treatment.

Footprint calculations

Footprint calculations cover construction/dismantling, operation and production. An inventory of consumed material and energy, produced material and energy, as well as greenhouse gas emissions is drawn up. Depending on waste composition and on the performance of each installation, the Ecological Footprint of one tonne of waste collected and/or treated can thereby be assessed. On the one hand, the Footprint corresponds to the surface of bioproductive area required per year to produce resources consumed and absorb greenhouse gases generated

(CO_2, CH_4 and N_2O), and, on the other hand, to the surface saved by waste recovery, which corresponds to a negative Footprint. SITA France has already used these tools in several case studies to compare scenarios of waste management and identify where progress in terms of Footprint could be made (cf. the case study below).

Case study

SITA has used the Ecological Footprint to compare four scenarios of municipal solid waste management of a French region of 300 000 inhabitants. The considered scenarios included:

1. separate collection and composting of green waste and landfilling with biogas recovery of other waste;
2. separate collection and composting of green waste and incineration with energy recovery of other waste;
3. separate collection and composting of bio-waste and green waste and landfilling with biogas recovery of other waste;
4. separate collection & composting of green waste and mechanical biological treatment (MBT) of other waste with compost and RDF production.

Results show that, per treated tonne, composting of green waste (scenario 2) would have a beneficial impact compared to landfilling (scenario 1). On the one hand, composting mainly emits CO_2, not accounted for since it comes from biomass. On the other hand, it contributes to reducing the impact of landfilling by reducing the fermentable fraction of waste sent to landfill. However, the Ecological Footprint of scenario 1 could significantly be reduced simply by improving the biogas collection efficiency. In this case study, scenario 4 appears as the best one in terms of Ecological Footprint, due to its high waste recovery rate: in addition to the production of compost, metal recovery but also RDF production (which avoids fuel consumption) contribute to saving resources. However, it must be noted that, in this last scenario, all the benefits of waste recovery could be lost, depending on the distance between the MBT plant and the place where compost and RDF are used.

Methodology

As it has already been said, the presented case study concerns a French region of about 300 000 inhabitants, who, in turn, produce a total of 99 356 tonnes of residual MSW. The waste composition is presented in Figure 9 below:

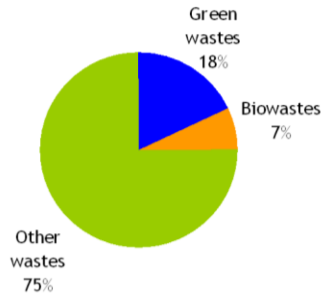

Figure 9: Residual MSW composition in the French case study.

The challenge was to improve the existing waste management system, which is done in four simple steps:

1) Elaboration of a detailed description of the existing waste management of the territory, taking into account the quantity and composition of waste; the number, localisation and capacity of transfer, sorting, treatment and recovery facilities; the existing local and national waste management policy and regulations, etc.;
2) Elaboration of three alternative scenarios, presented in Figure 10:

	Characteristics	Scenario 1 Current situation	Scénario 2	Scénario 3	Scénario 4
Separate collection and composting of green waste	Compost production	X	X	X	X
Landfilling of remaining residual waste	Biogas recovery and electricity production	X		X	
Separate collection and composting of biowaste	Compost production			X	
Incineration of remaining residual waste	Electricity and heat production		X		
Mecanial-biological treatment of remaining residual waste	Compost and RDF production				X

Figure 10: The elaboration of three possible scenarios.

3) Assessment of the existing situation and the three alternative scenarios according to such criteria as regulations (e.g. Grenelle 2 Law: recycling objectives, reducing waste production objectives, etc.), costs (treatment costs, tax, etc.) and environment (ecological footprint). The assessment is presented in Figure 11:

	Regulation	Economy	Environment
Existing situation (with landfilling)	++	++++	+
Scenario 2 (with incineration)	++	+	+++
Scenario 3 with composting)	++++	+++	++
Scenario 4 (with MBT)	++++	++	++++

Figure 11: The assessment of different scenarios.

4) Conclusions – choosing the best option, which turned out to be scenario 4.

All in all, the objective of Waste Ecological Footprint calculations is to assess and compare waste management scenarios in order to identify levers to improve their environmental performance. As it is a artifical indicator, Ecological Footprint can make communication easier with stakeholders and then be used to accompany the implementation of "lower Footprint" measures. This can help the public and decision makers to approach sustainable development and waste hierarchy in a concrete (even if only partial) way.

3.3. Mixed waste plastics – a case study

This interesting case study from Prachovice in the Czech Republic was presented by Mr. Bruno Fux of Holcim Group.

LCA_4Waste

Mr. Fux began by stating that Holcim supported the development of an LCA tool at the Swiss Federal Institute of Technology (ETH) in conjunction with other NGO's, governmental organizations, a consultant agency and the association of waste incinerators in Switzerland. The result of this effort is a customizable Microsoft Excel tool named "LCA_4Waste". The said tool currently consists of three modules, the first of which, co-processing, can be used as a stand-alone module to compare the usage of alternative fuels and raw materials in different clinker production scenarios. It can also be used in combination with two other waste treatment modules: landfill and incineration, to compare waste treatment among these different alternatives. All the modules draw on expert data accumulated from the different relevant industries.

LCA$_4$Waste helps Holcim to prove adherence to the Holcim AFR Policy and the Holcim/GTZ Guidelines (cf. Section 2), based on two principles:

1. "When using AFR our goal is to contribute to the preservation of natural resources or to the reduction of the global environmental impact."
2. "Co-processing does not hamper waste reduction efforts, and waste shall not be used in cement kilns if ecologically and economically better ways of recovery are available."

Case study

It must be noted that most of the MSW is still landfilled in the Czech Republic, even though there is a slight trend away from it. The case study from Prachovice, in the Pardubice Region of the Czech Republic, compares mixed waste plastics co-processing to land-filling and incineration (see Figure 12 below):

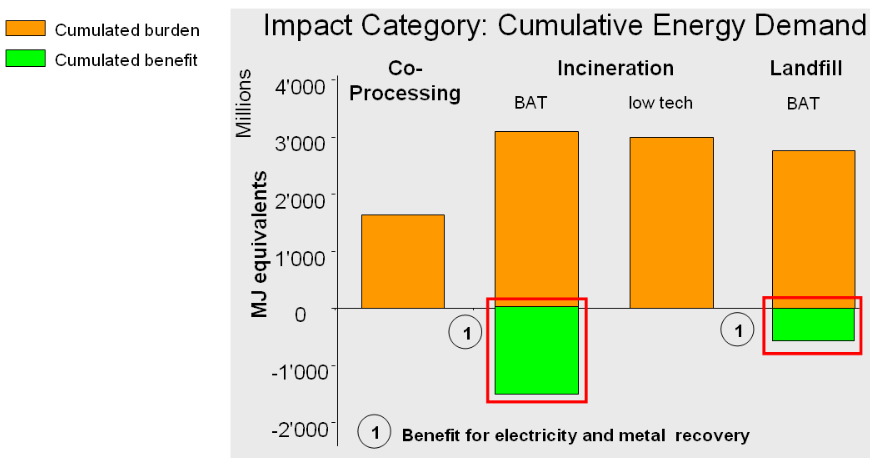

Figure 12: Mixed waste plastics co-processing vs. landfilling and incineration (BAT = Best Available Technology).

Co-processing as waste treatment option is ecologically more beneficial than landfilling and low technology incineration for mixed waste plastics in the considered life cycle impact assessment methods acidification, global warming potential and cumulative energy demand. It also becomes clear that BAT (Best Available Technology) incinerators reach co-processing performance by levelling out burdens and benefits, while landfill BAT exceeds low tech incinerator performance. This case study thus shows that co-processing is a competitive waste management option, as it is ecologically more beneficial than landfilling and low technology incineration according to Climate Change, Acidification and Cumulative Energy Demand criteria. Moreover, it allows for avoidance of CO_2 emissions and methane emissions from incineration and landfilling, reduced NOx emission when using mixed waste plastics as Solid Recovered Fuel (SRF) in clinker production, and avoidance of coal firing and transport due to lower coal consumption (supply chain burden reduction). It is also worth noting that BAT incinerators and co-processing are ecologically comparable options for the treatment of mixed waste plastic or SRF, with regard to the impact categories climate change/energy demand and acidification. Through recovery of energy and emission abatement technology, BAT incinerators are able to reduce their net burden to the level of co-processing or even below. Major drivers are the efficiency of energy recovery and the environmental burden of the local electricity generation.

In conclusion, it can be said that LCA_4Waste is a decision support tool for both industries and authorities. It is meant to strengthen and foster internal and external co-processing acceptance through the development of ecological arguments; catalyze dialogue and support co-processing lobbying and advocacy with key external stakeholders to reinforce one’s local network; and, finally, enter in a trustworthy dialogue with one’s customers based on ecological benefits of co-processing and strengthen relationships, while supporting capacity building on co-processing with well founded scientific ecological arguments.

3.4. Modelling waste management systems – SIMUR

Municipal waste management is an evolving field. Each town or city adopts new tools and systems to achieve maximum recovery of resources from waste and comply with legislative requirements and planning. Obviously, a single clear solution to efficient waste management is not possible; it is necessary to evaluate the waste management models through a unified methodology. Ms. Marta Vila Gambao from the Urban Ecology Agency of Barcelona presented an analysis tool based on an overview of waste management systems, its consequences and LCT.

The SIMUR tool

The Urban Ecology Agency of Barcelona has created a software tool which simulates waste management systems called SIMUR (“Sistema de Información y Modelización Urbana aplicada a Residuos”). It can be used for different purposes, such as comparing different models, detecting problems and needs, checking if a particular model has achieved its objectives, as well as evaluating the potential scenarios. It can be used to analyze real situations or show how results change when changing certain parameters. It also allows for an analysis of future scenarios and their possible results: mass balance, energy balance and associated environmental impacts. In short, SIMUR makes it possible to develop more efficient waste management systems.

LCT and SIMUR’s structure

SIMUR simulates waste management throughout the whole life cycle, i.e. from the production phase to disposal, including the following stages:

1. management at the point of generation:
2. collection and transport to the first point of treatment;
3. treatment systems;
4. final destination: recycled, reused, disposal, etc.

The tool’s structure is as follows:

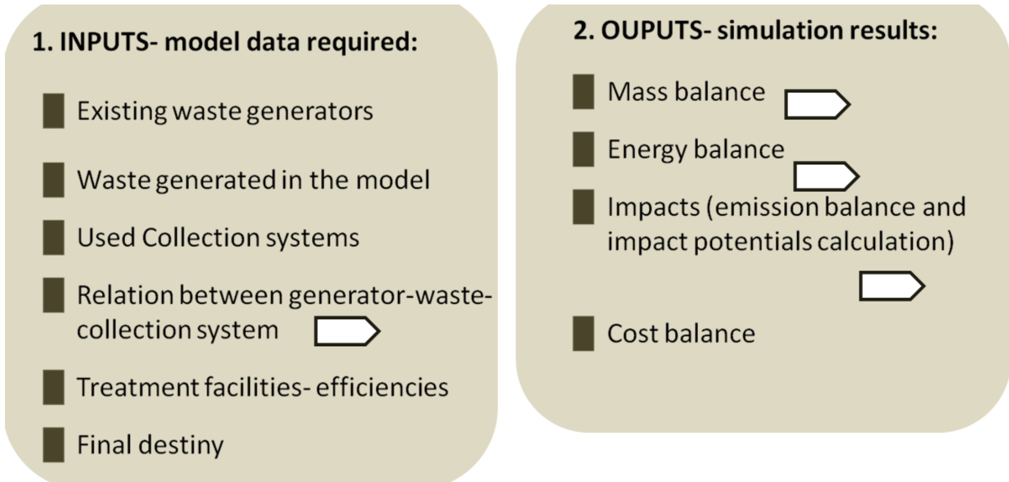

Figure 13: The structure of the SIMUR tool.

Each section mentioned above consists of a series of data forms required for its operation and a display of output screens showing the results of the simulation (tables, charts, images, etc.). Moreover, a “Tools” section has been created, providing the user with additional information such as background, data sources, glossary, etc.

Practical applications

Since 2002, when SIMUR was created, it has been tested and verified to ensure proper functioning and introduce improvements or adaptations, resultant from its practical applications.

The Urban Ecology Agency of Barcelona carried out numerous evaluation projects of waste management systems on different scales (municipalities but also neighbourhoods and districts). These studies had different purposes, including:

- gathering information on different management systems and making comparisons to define management strategies on a regional level;
- calculating waste emissions for local Action Plans for Sustainable Energy and Climate Change Mitigation;
- including the results in LA21 diagnosis;
- possible model changes;
- drafting Environmental Sustainability Reports for Strategic Environmental Assessment Process for plans and programmes (PROGREMIC- PGRUG).

In summary, SIMUR can be described as a “common language” to calculate environmental impacts of waste management, as well as a flexible, easy and understandable tool, adapted to the most common waste management systems in Spain.

4. Panel discussion and conclusions

4.1. Panel discussion

The panel discussion was moderated by Mr. Michaël Ooms of RDC Environnement, and fed by several experts in the field, representing different views on LCT: Mr. Bruno Fux of Holcim Group, Mr. Jan Manders of CEWEP (Confederation of European Waste-to-Energy Plants), Mr. Stéphane

Arditi of EEB (European Environmental Bureau), Ms. Alexandra Lalet of Sita France and Mr. Francis Radermaker from the Ministry for Environment of the Brussels Capital Region[10].

The discussion was structured around the following four questions:

1. How do you see the role of LCT for municipal waste management policy priorities?
2. Do you see a case to go the European Court of Justice to clarify the interpretation of LCT?
3. What is the place of co-processing in the waste management hierarchy based on LCT?

Below you may find some key responses from the panellists that we recorded:

1. How do you see the role of LCT for municipal waste management policy priorities?

Mr. Jan Manders (CEWEP): LCT is useful but requires further development. The WFD should be more specific regarding 'how' to implement LCT in waste management policies. The assistance of professionals as JRC (Joint Research Center) on how to apply LCT would be most appropriate. If no clarification, there will be a lot of confusion.

Mr. Stéphane Arditi (EEB): Municipalities in the end are the final decision makers regarding waste management policies. LCT/LCA is one of the possibilities to guide the decision and should be recommended as it can facilitate the direction for Local Authorities to optimise recycling. However, the analysis seldom provides conclusive results. LCT/LCA is better than nothing but it has to be used as a tool to support the decision making, facilitate the deliberation. The risk is to use it as an authoritative argument

Mr. Bruno Fux (HOLCIM): Data collection in LCT/LCA is key as well as the interpretation of the results, preferably peer reviewed. The scope of the LCT should also allow for analysis of economic and social impacts.

Mr. Francis Radermaker (Brussels Capital Region): It has not been forgotten that waste management represent 3% of the GHG emissions and the upstream activities are key. It's important to set up standards (Quality systems) to ensure a more effective use of LCT on waste management.

Mr. Bruno Fux (Holcim Group): When publishing a study you need to ensure that data is very accurate and interpretation is taking place in a systematic way.

[10] See Annexe 2 for the panellists' position papers.

Mrs Alexandra Lalet (SITA): LCT is applicable to waste management policies but the challenge is to transform this theory into practice. It is also important to distinguish LCT from LCA.

Mr Michael Ooms (RDC Environment): The interpretation phase is key and sensitivity must be assessed (variability/uncertainty). Then the experience shows that from 100 parameters analysed in the beginning of a study, only 5 to 10 parameters really influence the waste hierarchy. One of the challenges is also to take into account waste prevention!

2. Do you see a case to go the European Court of Justice to clarify the interpretation of LCT?

Jan Manders(CEWEP): LCT is useful but not easy to apply. There is a need for improvement, harmonization and good practices. This is not the role of the Court of Justice.

Mr. Stéphane Arditi (EEB): The first principle is to follow the waste hierarchy as defined in the Directive. If derogation occurs from the waste management hierarchy, then justification needs to follow and LCT can be used. But LCT cannot substitute the deliberation process. In addition, LCT is and should continue to be applied in product / service policy.

The representative from EPA Ireland stated that by taking a case to the European Court of Justice, from a regulator's point of view, it could end up being a very slow process, a process that could inhibit procedures on implementation of LCT. Irish EPA plans to use LCT in any case, not only for derogations to the hierarchy.

Mr. Francis Radermaker (Brussels Capital Region): we could estimate that 99 % of the decisions are valid following the hierarchy, so LCA might not be such an issue…

Mr Michael Ooms (RDC Environment), in answer to Mr Radermaker: what might be true for LCA may not be the case for LCT.

Mr. Francis Radermaker (Brussels Capital Region): an additional (and more general) issue is the fact that biogenic emissions are not taken into account in the calculation models for GHG emissions according to the Kyoto Protocol.

Mr Stephane Arditi (EEB): and there might also be a contradiction between energy policy objectives and waste policy objectives, an example is the case of biowaste composting versus biowaste incineration (as a renewable energy).

3. What is the place of co-processing in the waste management hierarchy based on LCT?

The new waste framework-directive formulate a (5) priorities order which must be implemented. The juridical obligation to respect this hierarchy has only one limit: the proof, on the basis of life cycle thinking (LCT), that there are other better environmental solutions.

But what is exactly "life cycle thinking" ? There is no legal definition of this concept. It's clear that it's more that the use of a (standardized or not) Life Cycle Analysis. The European Commission has been publishing some guidelines but they have no legal implication and they are not clarifying lots of issues.

In particular, the new waste legal hierarchy imposes to give a priority to the recycling versus any form of energy recovery . But, some questions remain open, for instance, what is the exact legal place for all those waste operations which are contributing at the same time to some waste material recovery and to some waste energy recovery.

For example, the EU policy does not give immediately an answer to the question of the priority to give to the anaerobic digestion combined with agricultural recovery versus direct waste composting or precisely to the "co-processing" for different kinds of waste flows versus simple recycling or incineration.

If the concept of "LCT" opens the door to some exceptions to the legal order with 5 levels, it appears also to be the justification of those 5 levels. As a consequence, we have to use this concept when we are confronted to the choice of different potential waste treatment alternatives: precisely in the case where we have the possibility to do waste treatment by "co-processing" or by others operations of waste recovery.

For us, it is clear that before any choice of waste treatment, there is a legal obligation to do something at the source of the waste flow to reduce its volume or its hazardousness (including some operations of preparing for reuse).

At a second stage, there is an obligation to develop some forms of recycling before trying to recover some energy. And it is also clear that there is an obligation to prioritize some forms of energy recovery before to go to some simple incineration plants.
This means that, for the majority of municipal waste, we have first to act at the level of prevention and reuse and then we focus on recycling activities (based in the majority of the cases on selective collection)

For the ultimate residual waste fraction of municipal waste (which is not more than 10-15% from our point of view), the possibility to apply MBT , Co-processing or other kind of waste recovery seems to be to evaluated seriously …using some life cycle thinking data.

For some specific waste flows like sewage sludge, the opportunity to develop some co-processing activities seems really attractive, namely because in that case simple direct recycling represents a lot of hazardousness. And also because the co-processing can contribute to some material recovery with some energy recovery in a broad context of hazardousness reduction.

5. Conclusions

It goes without saying that, at this stage, public authorities and private enterprises make strategic choices for waste treatment on the basis of legal prescriptions which are open to many different (and sometimes inconsistent) interpretations. In particular, the implementation of "Life Cycle Thinking for Waste Management Options" should be explicitly set out and defined for the ranking of certain recycling alternatives vis-à-vis other waste treatment processes which combine material and energy recovery options. These would include, for example, co-processing or anaerobic digestion, followed by composting.

The meeting concluded that various non binding tools exist for LCT/LCA applied to waste management options, including Life Cycle Analysis, CO_2 balance, Energy Balance, Ecological Footprint, Cost-Benefit Analysis, Social Cost Analysis, etc., that need more harmonization and standardization. Various LCA tools are alike whereby the same parameters and inputs are used but with different outputs.

LCT is a concept, a way to assess an activity, a project. The complexity comes from the practical implementation of this concept:

- LCT implies a multi-criteria analysis (economic, social and environmental criteria): where should the analysis stop? When can the analysis be considered complete?
- Because of technical or scientific limits, the use of tools, such as LCA, can not bring all the answers yet.
- Need practitioners to use a clearer methodology and interpretation of LCT backed up by academics and JRC.

LCA modelling of waste management systems is a complex issue as well as the subsequent analysis. Developing waste management strategies is a delicate task which encompasses several aspects that cannot be fully included in a LCA analysis.

Life cycle thinking and LCA are explicitly mentioned in a Thematic Strategy on the prevention and recycling of waste and related implementing measures. LCT is a mindset for policymakers to make every effort to take into account relevant life-cycle aspects. In many cases this means using common sense to look at the wider picture while in others it could mean using assessment tools such as LCAs.

Conducting a LCA to support decision making in waste management may not always be needed, or even helpful. There may be instances in which evidence from previous work is enough to support decision-making or when simple, straightforward criteria are sufficient to unambiguously identify the environmentally preferable waste management option.

The place of LCT in the implementation of the waste hierarchy might also need some clarification: many observers interpret the dispositions of the Directive in the sense that LCT is needed when it comes to justify derogation to the hierarchy in the implementation of waste management policies. Others believe LCT must be used more systematically and serve as basis when shaping those policies.

Conducting a LCT/ LCA might be an interesting option due to the fact that the decision may affect multiple stakeholders and interested parties, that the waste stream(s) involved in the assessment may pose threats to the environment or human health or other specific reasons (e.g. burden shifting, market distortions, ...). Life Cycle Thinking may also be useful in the difficult task of evaluating and choosing among several often conflicting options, while clearly identifying the inherent trade-offs that each option may inevitably imply in terms of different environmental impact categories.

In such a case whereby conducting LCT as the preferred option, the meeting agreed that proper and accurate data collection and characterisation are key for the subsequent steps in the LCA. Also the studied parameters should be brought back to a limited number of key parameters through a sensitivity analysis and translated into easy interpretable data, in order to support decision-making by public authorities. The LCT process should also be transparent and involve major stakeholders at key steps in the process. Finally, the LCA should be peer reviewed, against international recognized quality systems (ISO, EMAS), by independent specialists.

As far as waste management is concerned, a life cycle approach is warmly recommended, as the environmental implications of most waste treatments fall outside the physical boundaries of plants and facilities. Thus, indirect (but inter-dependent) environmental consequences fall outside the control of waste operators. It is thus very possible that solutions focused on a specific environmental issue may cause worse environmental consequences upstream or downstream, or adversely affect an inter-dependent waste management chain.

In short, promoting LCT in the WFD without providing clear guidance and methodologies leaves the door open to misinterpretations and therefore poor or inadequate waste management options. In this context, how can any departing from the hierarchy be really considered as *“justified by lifecycle thinking”?* A minimum frame of the LCT should be defined so that one can consider that a study implying LCT is complete enough to justify or challenge a policy. A first necessary step is to develop a new type of knowledge base taking into account life-cycle information. This knowledge should be used to design environmentally and cost-effective waste management policies. It should help to define what information on waste is relevant to policymaking and to ensure that such information is taken into consideration as an integrated part of policymaking.

6. Appendices

Appendix 1

Programme of the International Seminar on the Interpretation of Life Cycle Thinking in the Waste Management Hierarchy

Day 1 **– 5 July 2011**

14h00: Welcome

- **14h15: IntroductionJean Pierre Hannequart**
  President of the Association of Cities and Regions for Recycling and sustainable Resource management (ACR+)
- **Jean-Pierre Degré**
  Senior Vice-President Alternatives Resources Holcim Group Support

14:45: Toward International Recognition & Rules for Co-processing - From Chile to UNEP / SBC - **Andres Jensen,** *UN/Basel Convention, Chile*

15h00: How to address waste management issues with LCT

- "Life Cycle Thinking for Local Authorities", **Cok van Bergen Henegouw**
  Maastricht University & HVC groep Alkmaar, The Netherlands
- "Ecological Footprint of organic waste management", **Alexandra Lalet**
  Policy Officer, SITA France
- "Mixed Waste Plastics – a Case Study from Czech Republic"
  Prahovice, Czech Republic
- "Modeling Waste Management Systems", **Marta Vila Gambao**
  Coordinator of Centre for Waste Reduction and Recycling, Agència d'Ecologia Urbana de Barcelona, Spain

16h00: Interactive session "LCT in waste management schemes" - panel discussion with key stakeholders

- **Michaël Ooms** - Moderator
  Managing Director, RDC Environment
- **Bruno Fux**
  Project manager - Holcim Group Support SD-AR
- **Jan Manders**
  Deputy President, *Confederation of European Waste-to-Energy Plants (CEWEP)*
- **Stéphane Arditi**
  Senior Policy Officer for Product and Waste, *European Environmental Bureau (EEB)*
- **Alexandra Lalet**
  Policy Officer, SITA France
- **Francis Radermaker**
  Cabinet Advisor, Ministry for Environment of the Brussels Capital Region

17h00: Roundtable / Discussion

17h45: Wrap up and conclusions

18h00: End of day 1

Day 2 **– 6 July 2011**

Site Visits – <u>Two approaches to waste treatment operations with both material / energy recovery</u>

8h30: Meeting at ACR+ offices: Avenue d'Auderghem 63

8h45: Departure to Lille
In the bus: summary of previous day/Introduction of Day 2

10h30: Study Visit

- Anaerobic Digestion centre: Sequedin, Lille Métropole

A quarter of our household waste is organic waste, which breaks down naturally and can then be turned into compost or biogas. With a capacity of 100 000 tonnes per year, the anaerobic digestion centre does not only produce compost, but also recovers the fermentation gases. The recovered methane gas is later converted into fuel that can, for instance, power vehicles.

12h-13h30: Lunch in Sequedin ("Estaminet La Calèche")

14h30: Study Visit

- Pre – processing centre: Geocycle Seneffe

This industrial waste pre-treatment platform recycles waste into solid or liquid substitute fuels, suitable for the cement-making process. Replacing the incineration of industrial waste by recovering them as substitute fuels reduces overall emissions of greenhouse gases. Moreover, the mineral fraction of the waste and its ash is incorporated into the material fused to form clinker, the main component of cement. So there is no final residue, and all the waste is recovered as energy and raw materials.

16h30: Back to Brussels/End of day 2

Appendix 2

Panellists' position statements

These are direct quotes from the experts' position papers and represent their particular views.

Bruno Fux, Holcim Group Support

Waste management hierarchy, promoting prevention, re-use, recycling, recovery and, only as a last option, disposal, is well acknowledged. However, the "traditional" hierarchy needs to be complemented with a layer called "co-processing". Co-processing is the use of waste materials in energy intensive industries, substituting fossil fuels and natural resources. Providing energy recovery and material recycling at the same time, co-processing in cement kilns is located between recycling and recovery, clearly superior to waste to energy incineration plants.

Life cycle thinking can complement the general concept of waste management hierarchy. For example, an LCA for a specific waste stream in a given region can conclude that resource co-processing might be environmentally superior to recycling. In this case, one has to deviate from the waste management hierarchy and chose the option with the best overall environmental performance. LCT can also refine the waste management hierarchy, for example by indicating which type of recycling delivers the best overall environmental outcome. It can, therefore, help to identify the option with the best environmental performance amongst different options on the same level of the waste hierarchy.

Jan Manders, CEWEP

LCT is a useful tool to determine the best waste management option in a particular situation. It should be used cautiously, though, and be based on a commonly accepted methodology, taking into account the whole waste management system. LCT should be carried out for specific waste streams (e.g. starting with the most important ones) and peer-reviewed by external experts on LCA (e.g. universities).

In the cases where effective source separation is in place, Life Cycle Thinking can be applied to the remaining waste in a pragmatic manner. Following source separation, for the remaining polluted waste that is normally not suitable for high quality recycling, energy recovery will, in most cases, provide the best environmental and economic outcome, according to Art. 4 of Waste Framework Directive.

Stéphane Arditi, EEB

In a situation where LCT/LCA is conducted only to support derogation (and which is not even a systematic requirement in national transposition today!), we both gain and lose. We gain, as, at least, we can ask for a proper reference to resist abusive deviations from the hierarchy. But we also lose, as we reduce the opportunity of a more democratic, participative process to review and interpret LCAs. As a result, we may miss a chance to set more relevant integration of technologies and behavioural approaches for waste management. LCA should not be the reactive tool reserved to the "bad guys": it could become the proactive tool for collectively optimizing the combination of waste management options.

The cost consideration of the different options cannot be neglected, which is why it is also recommended by JRC to complement environmental LCA with Life cycle cost analysis. In that economical dimension, the art 4 of WFD stipulates clearly that the key economical criterion to derogate from the hierarchy is the economical viability (the non viability of solutions higher in the hierarchy). And economic viability should not be confused with the most cost-effective option. Local employment is also to be considered!

Alexandra Lalet, SITA France

SITA regularly conducts truncated LCAs to justify the choices it proposes to its customers. In these studies, all the stages of the life cycle of wastes are well covered, but only one or two environmental impacts are assessed, basically energy consumption, greenhouse gases effect and/or ecological footprint. This assessment is clearly not complete. Only an LCA can give an overview of several environmental impacts of a waste management scheme, and even in this case, this overview is not complete, since certain impacts would still not be taken into account (noise, odours and benefts of compost for instance) and others, like toxicity, are still the object of research. In any case, LCA allows operators and customers to be aware that waste management, like any activity, has several environmental impacts.

LCA is a complex tool which requires training to properly understand and interpret the results. On this last point, work is really necessary to make LCA a real decision support tool. Guidelines are also required on how to conduct such studies and which methodological choices to adopt. LCT and LCA in waste management schemes are relevant when implemented at a local scale or on a specific project. ISO Standard indicates that results of LCA cannot be generalized. This principle must always be kept in mind. According to the waste composition, the performance of the existing facilities or the location, the best option from an environmental point of view is not always the same from one region to another. The waste management industry, because of its diversity of technologies, searches the right solution for all situations.

Appendix 3

Life Cycle Thinking TIMELINE[11]

1963: Early studies known as Resource and Environmental Profile Analyses (REPA).

1969: First comparative multi- criteria environmental study for Coca Cola - became basis for the current method for life cycle studies.

1991: The Society of Environmental Toxicology and Chemistry (SETAC) develops the Impact Assessment method for LCA.

1992: First European scheme on Ecolabels, established by the European Commission; World Business Council for Sustainable Development (WBCSD) founded by industry to address sustainability.

1995: SETAC develops Code of Practice for Life Cycle Assessment; first Life Cycle Assessment on a car – VW Golf.

1996: International Organization for Standardization (ISO) launches first standards on Life Cycle Assessment.

2001: European Commission releases Green Paper on Integrated Product Policy (IPP) building on Life Cycle Thinking.

2002: United Nations Environment Programme (UNEP) / SETAC Life Cycle Initiative launched.

2003: European Commission Communication on Integrated Product Policy

2005: European Platform on Life Cycle Assessment established at the European Commission; EU Thematic Strategies on the prevention and recycling of waste and the sustainable use of natural resources published.

2006: First version of the Commission's European Reference Life Cycle Database (ELCD) goes online.

2007: Start of development of International Reference Life Cycle Data System (ILCD) Handbook.

2008: European Commission launches Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan. First public specification for carbon footprinting published (British PAS2050).

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[11] After European Commission, *Making Sustainable Consumption and Production a Reality. A guide for business and policy makers to Life Cycle Thinking and Assessment.* Luxembourg: Publications Office of the European Union, 2010

2009: ISO initiates development of first international standard for product carbon footprinting; the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI) start drafting a Green House Gas (GHG) Protocol Product / Supply Chain Standard and life cycle based Scope 3 Corporate Standard.

2010: Launch of the ILCD Handbook by the European Commission.

Appendix 4

Photos of the study visits on Day 2 of the Seminar

© ACR+. Study visit to the anaerobic digestion centre in Sequedin, 6 July.

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© ACR+. Study visit to the pre-processing centre in Seneffe, 6 July.

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