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IMPROVEMENT APPLICATION OF THE LCA METHOD IN PRACTICE

Predrag COSIC, Ivica GLUMPAK

University of Zagreb, Faculty of Mechanical Engineering, Zagreb, CROATIA

ABSTRACT
Even if the biggest individual emissions are reduced, the total environmental impact in some areas will still rise as a consequence of the growing flow of products and the activities to which they are leading. LCA approach includes different tools for possibly implementation through process of product design and process planning by help: ISO standards 14040-series, IPPC directive, national legislative, influence of state/non-state organizations, mass media, etc. Our aim is to investigate national and ISO norms and EU/CRO legislative and how they can improve application of the LCA method in practice. It would be presented by selected LCA case study.
Keywords: sustainable production, life cycle assessment

1. INTRODUCTION

In general, sustainability is ability of some state or process to last indefinitely. The most common definition of sustainable development is: ˝Development that meets the needs of the present without compromising the ability of future generations to meet their own needs˝ (Definition by World Commission on Environment and Development). This definition is mostly referred on sustainability of the eco-system, in other words, on ability of the eco-system to maintain its natural processes, functions, biological diversity and productivity in the future. For sustainability to be met, natural resources must be used at a rate at which the nature can compensate these resources.

Modern approach to sustainable development includes two other components, beside environmental component. One component includes social goals, such as decrease of poverty, humanization of labor, etc. The other component includes economic goals, such as productivity, economic growth, increase of life standard, etc. Sustainable development can be represented as an optimum of these three functions.

2. ECOLOGICAL APPROACH TO PRODUCTION

From environmental point of view, there are four main approaches to production: [1]

1. **Traditional approach:**
- Waste disposal on landfills, incineration, etc.
- ˝End-Of-Pipe˝ - dealing with waste-related problems after they are already created

2. **Preventive approach:**
- Cleaner production with minimization of waste quantity
- Environmental Management Systems
- Focus on more effective usage of natural resources

3. **Product-focused approach:**
- Reduction of product's environmental load through its design process (˝Eco-design˝)

4. **Dematerialization:**
- Increase of product's number of services; Decrease of material quantity per single service

To reduce production's environmental load, one can act in two separate directions: changes in production process, or changes in product's design. In order to achieve these goals, one can use some of specific tools created within the principles of industrial ecology. Here is the list of some of these tools:

- ˝**Eco-design**˝: Set of rules and principles which is intended to eliminate harmful influence through correct choices in product development phase. One example of graphic evaluation of results is illustrated on Figure 1.

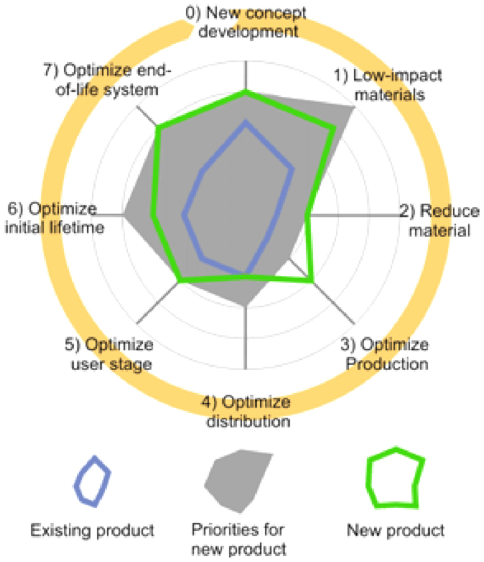

Figure 1 Eco-design strategies wheel [1]

- ˝**Extended Products**˝: Tool with goal of increasing number of services (non-tangible part) per unit of product.
- ˝**Cleaner Production**˝: Cleaner Production is the continuous application of an integrated preventive environmental strategy to processes, products, and services to increase overall efficiency, and reduce risks to humans and the environment. Cleaner Production can be applied to the processes used in any industry, to products themselves and to various services provided in society. For production processes, Cleaner Production results from one or a combination of conserving raw materials, water and energy; eliminating toxic and dangerous raw materials; and reducing the quantity and toxicity of all emissions and wastes at source during the production process. For products, Cleaner Production aims to reduce the environmental, health and safety impacts of products over their entire life cycles, from raw materials extraction, through manufacturing and use, to the 'ultimate' disposal of the product.
- For services, Cleaner Production implies incorporating environmental concerns into designing and delivering services. [2]
- ˝**Eco-Efficiency**˝: This tool is defined as the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the earth's estimated carrying capacity. However, the concepts of Eco-Efficiency and Cleaner Production are almost synonymous. The slight difference between them is that eco-efficiency starts from issues of economic efficiency which have positive environmental benefits, while Cleaner Production starts from issues of environmental efficiency which have positive economic benefits. [2]

Figure 2 illustrates comparison between Eco-Efficiency and Cleaner Production based on several criteria.

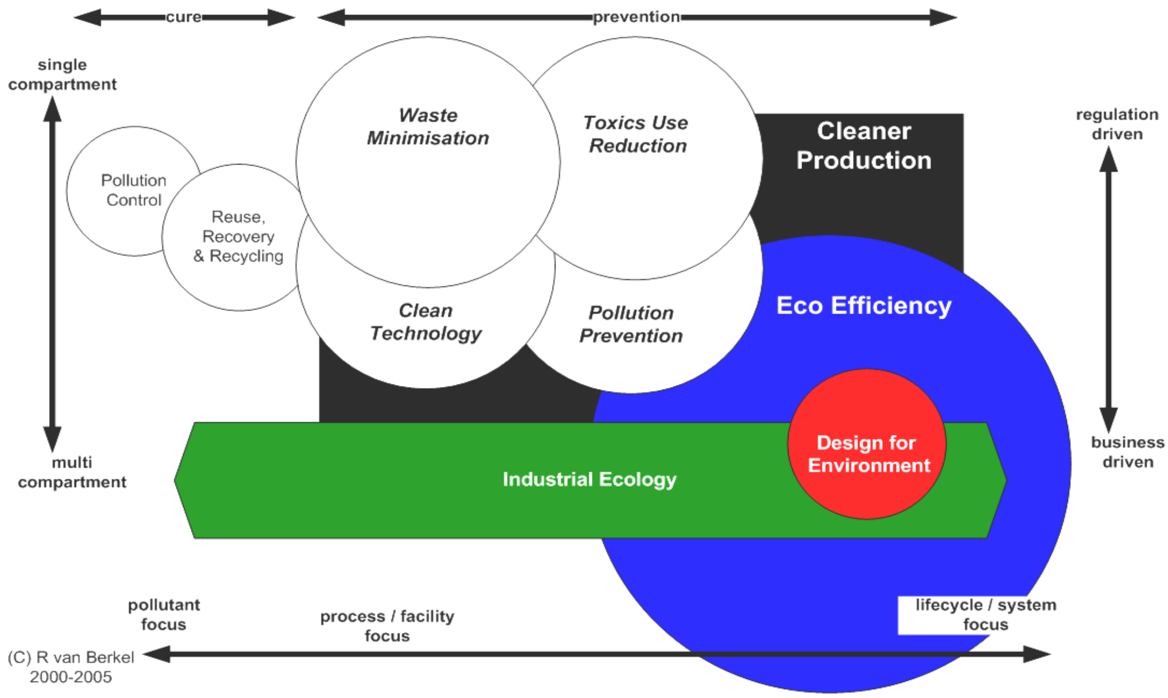

Figure 2. Comparison between Eco-Efficiency and Cleaner Production [3]

- **˝Life Cycle Assessment˝ (LCA):** This is a technique for assessing the environmental aspects associated with a product of its life cycle (''cradle-to-grave principle'', illustrated on Figure 3). The most important applications are: analysis of the contribution of the life cycle stages to the overall environmental load (usually with the aim to prioritize improvements on products or processes), and/or comparison between products for internal or external communications.

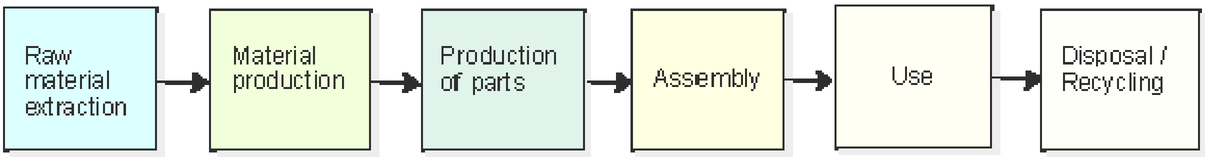

Figure 3. Life cycle stages of a product [3]

In recent years life cycle thinking has become a key focus in environmental policy making. A clear example is the concept of IPP (Integrated Product Policy) as communicated by the EU. Standard LCA study consists of four stages (Figure 4): defining the goal and scope of the study (1), life cycle inventory stage (making a model of the product life cycle with all the environmentally relevant inflows and outflows)(2), life cycle impact assessment (understanding the environmental relevance of all the inflows and outflows)(3), the interpretation of the study (4). [4]

The biggest disadvantage of the LCA study is that it is time-consuming (specially inventory analysis stage) and thus expensive. Time needed to perform the study often exceeds time needed for development of the product. To prevent this problem, number of software's for quicker application of the study were developed (SimaPro, Eco-It, GaBi, EIO-LCA, IDEMAT, etc.). These software's use ready-made databases, which replace very complicated measurements and calculations in inventory analysis stage. The data generated this way are less accurate, but in most cases accuracy is within the requirements of the study.

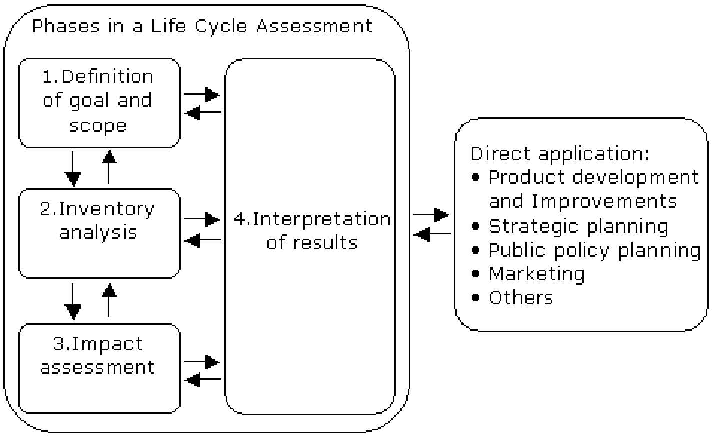

Figure 4 Phases of standard LCA study [5]

- **˝Life cycle management˝(LCM):** Use of LCA study results as feedback for continuous improvement of production, mostly in environmental aspect, but in every other aspect also.

3. ENVIRONMENTAL MANAGEMENT SYSTEM – EMS

An EMS is a voluntary management system for identifying, controlling and monitoring a facility's activities, which have potential environmental impacts. The framework provides structure and consistency for overseeing daily activities that shifts the environmental focus from reactive to proactive. Voluntary implementation of EMSs has increased throughout the world as industry and organizations realize their environmental and market place value.

EMS is continuous process of planning, evaluation and improvement of environmental performances, but also of product quality and organization. This continuous process can be graphically presented by Deming's circle. In Europe, two EMS-s are most commonly used: ISO 14000 series of norms and EMAS (Eco Management and Audit Scheme). Both of them are based on LCA principles. ISO 14001 is a standard for environmental management systems to be implemented in any business, regardless of size, location or income. The aim of the standard is to reduce the environmental footprint of a business and to decrease the pollution and waste a business produces. The most recent version of ISO 14001 was released in 2004 by the International Standards Organization (ISO) which has representation from committees all over the world. The ISO 14000 environmental management standards exist to help organizations minimize how their operations negatively affect the environment. In structure it is similar to ISO 9000 quality management and both can be implemented side by side. EMAS is, in fact, adjusted ISO 14000 norms to specific demands of EU legislative.

4. LCA ANALYSIS OF SELECTED PRODUCT

As an example of LCA analysis, a simple household coffee machine will be used. For this analysis, we used computer application ECO-it, which is based on method called ECO-INDICATOR 99. This method is based on LCA principles, and is very simple to use. It issue used for quick comparison between overall environmental impact of optional materials and processes in product development phase. Overall environmental impact of some material or process is expressed by points, which are already calculated by scientists and are based on various categories of environmental impact (CO_2 emissions, acidification, etc).The database contains ove 200 eco-indicators for various materials and processes, which are expressed in points per specific amount (kg, kW, m^2, etc).The user only has to define amounts.

The method is executed in five steps:

4.1 Defining the purpose of analysis:

The purpose in this case is to define which materials and processes in coffee machine's life cycle have the most negative impact on environment.

Note: Some of parts will not be included in analysis, in order to keep it simple, and only the production phase will be shown.

4.2 Defining the life cycle of the product:

Coffee machine's life cycle is represented as process tree in Figure 6.

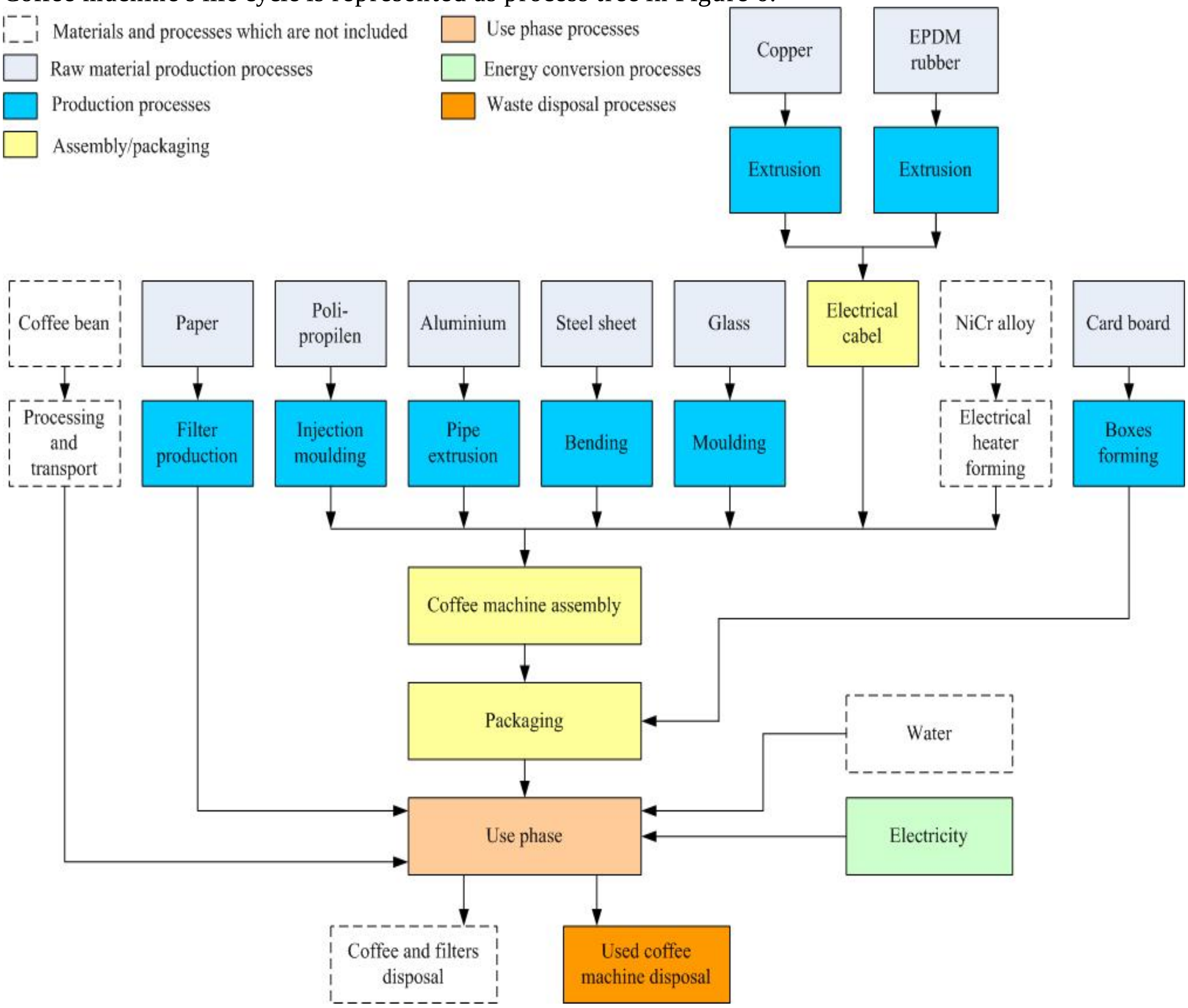

Figure 6. Simplified process tree for coffee machine [1]

4.3. Quantifying materials and processes: In this step the user must define specific amounts for all analyzed materials and processes, in order to calculate their eco-indicators. The specific amounts for coffee machine are presented on Figure 7.

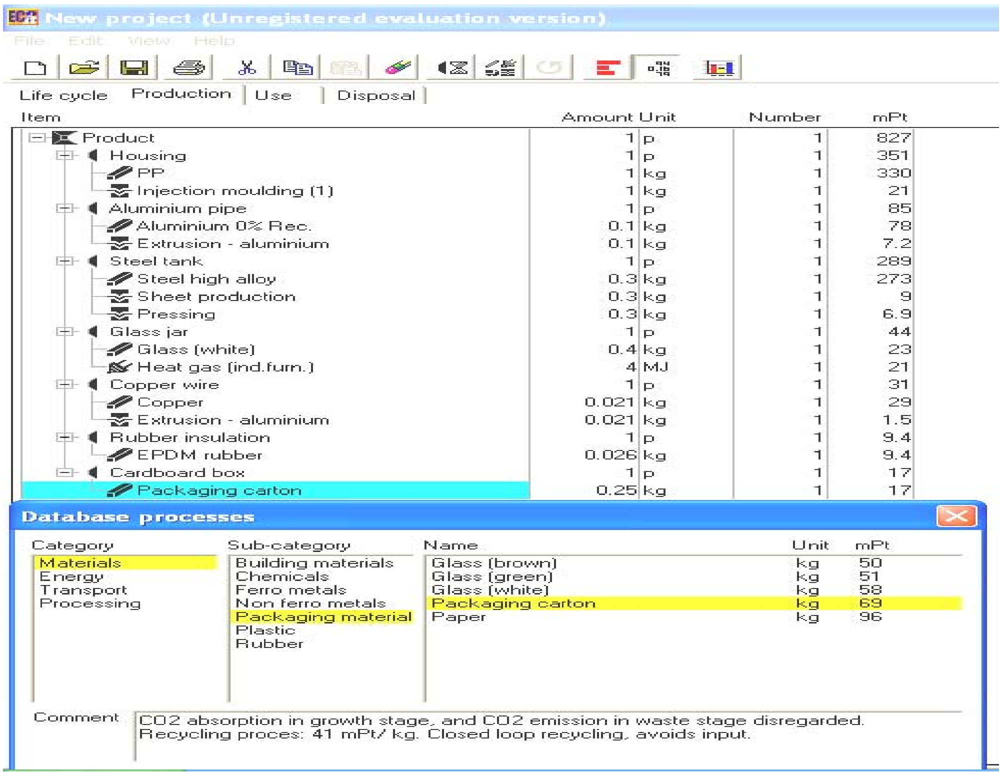

Figure 7. ECO-it data entry [1]

4.4. Data entry: The data are divided in three phases of a life cycle: production, use and disposal. For this demonstration, we will only use ´Production´ window. The user must retrieve materials and processes from database and enter their amounts, as illustrated in Figure 7.

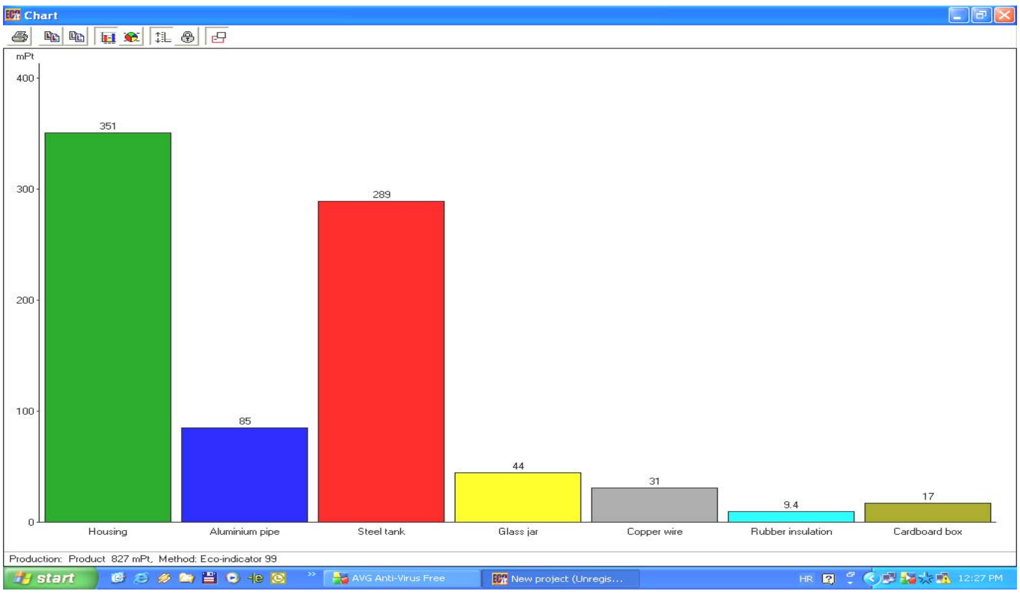

Figure 8. ECO-it results for production phase of cofee machine [1]

4.5. Results interpretation: In this step the user had the information on eco-indicators for all materials and processes (Figure 8). In our case, the highest score have polypropylene casing and steel tank (along with their production processes). If we want to improve our product environmentally, these are the first things to look into.

5. CONCLUSION

Significant parts of EU funds are intended for environmentally oriented production projects. The responsibility is equally distributed between Croatian government and production companies to use these funds for general (not only environmental) progress. LCA analysis provides very good analytical tool by which some subject can communicate its environmental efforts. But in the future, LCA analysis will not only be voluntary-based. EU environmental norms are getting more demanding, and LCA analysis will in some cases be necessary to meet these demands.

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