LIFE CYCLE ASSESSMENT (LCA)

Introduction

The realisation of the vulnerability of the earth's eco-systems has led to the design of new initiatives that aim to both assess and address an activity's impact upon the environment. Current knowledge nevertheless provides a conflicting basis for quantifying sustainability, as central issues such as resource use and resultant impact remain largely unresolved.

As environmental awareness has grown considerably during recent years, industry has been confronted with an ever-increasing demand for information about the management of its environment. The general public has concerns about a wide number of environmental issues such as the safety of plant, transport and products, pollution, and global sustainability. Public authorities increasingly demand information regarding the environmental impact of industrial activities. Society has the right to ask for this information and industry must plan for a future where there will be an ever-increasing spotlight on environmental issues. If the concerns and demands are not addressed then new plants and expansions will be blocked and new products will be rejected. There will be growing regulation and environmental taxation. Insurance and financing costs will rise. And a poor environmental image will make it difficult to attract new people into the industry. Thus it is in the self-interest of industry to work for the environment. For industry to be successful in the future it must demonstrate that it understands the environmental impact that it makes.

The general consensus remains that society must keep its activities within the Earth's true "carrying capacity" [UNEP 1991]. To this end well-established practices such as energy

audits, risk assessments, and mass balance exercises have evolved to become encompassed under a collective methodology of Life Cycle Assessment (LCA), which may be defined as: "the compilation and evaluation of inputs, outputs and potential environmental impacts of a product system throughout its life-cycle" [ISO 1997].

Thus, Life Cycle Assessment is considered to provide a sound methodology for describing environmental impact.

* To allow our industry to provide relevant information about its environmental impact, to promote best available technologies from an environmental point of view

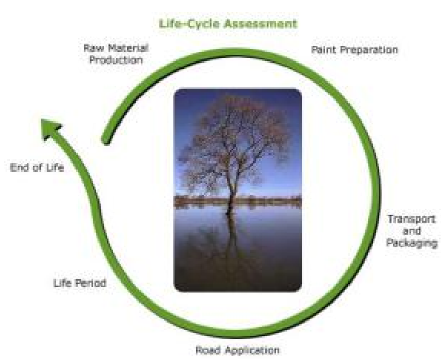
* To communicate how the industry activity is sustainable in terms of the environment

In other words, as a concept LCA targets the entire cradle to grave activities of a product or process; from the extraction and processing of raw materials to transportation and use, in addition to reviewing the issue of material re-use and final disposal. LCA therefore identifies the system processes and potential environmental burdens throughout a product's life-cycle.

Moreover as a philosophy, LCA is employed in order to attain the environmental goals of replacing ecologically damaging systems, reducing reliance on finite resources and minimising material waste. This has arguably resulted in LCA being perceived as a panacea for all environmental ills and is increasingly considered as a key tool for the justification and implementation governmental policies on sustainability

What is Life Cycle Assessment?

Life cycle assessment is a relatively new technique. As explained earlier, it aims to account for the environmental burdens created by a product or a service throughout its whole life cycle – "from cradle to crave". The technique had its origin in the energy studies in the late 1960s and in the early 1970s. Today it is a developed, standardised tool for environmental assessments. LCA evaluates from the environmental point of view all the resources and inputs needed for the system studied and all the outputs from the system, which are emissions to air, water and soil. LCA does not address the economic or social aspects of a product. Life cycle assessment covers the whole product system from raw material acquisition, transportation, material and product manufacture, product use and maintenance and recycling to final disposal. LCA provides a new point of view towards a product system and it can totally change the market profile of the product. A very bad eco-profile can even destroy a product. In the future environmental costs will be more and more transferred to the product price. So it will be beneficial to produce and buy products with lower environmental costs.



Life Cycle Assessment is a holistic tool for industry to evaluate the environmental impacts associated with resource extraction, transportation, manufacturing, use, disposal / recycle.

In other words, LCA is the assessment of the environmental impact of a product throughout its life cycle. The goal of LCA is to compare the environmental performance of products and services, to be able to choose the least burdensome one. The term ‘life cycle’ refers to the notion that a fair, holistic assessment requires the assessment of raw material production, manufacture, distribution, use and disposal including all intervening transportation steps. This is the life cycle of the product. The concept also can be used to optimize the environmental performance of a single product (ecodesign) or to optimize the environmental performance of a company. The term ‘emergy’ is often used as an analysis tool to determine embodied energy.

The pollution caused by usage also is part of the analysis. For a hydro electric power plant, for example, construction pollution is considered, but so is the decay in biomass on land flooded to create the dam because it cannot absorb CO2 anymore. This biomass decay is called “CO2 equivalent”. Common categories of assessed damages are global warming (greenhouse gases), acidification, smog, ozone layer depletion, eutrophication, ecotoxic and anthropotoxic pollutants, desertification, land use as well as depletion of minerals and fossil fuels.

LCA as a tool

In seeking to achieve the utopian ideal of placing all activities in a hierarchy of sustainability, the application and assessment of LCA must be carried out in a consistent manner. However the complex interactions experienced within all life-cycles often preclude detailed comparative analysis of differing functions, be they products or processes. As the very nature of industrial or organic system processes impede the formulation of rigid methodological rules, each activity often requires incompatible criteria of assessment. In order to address the inherent weaknesses experienced in the quantification and qualification of environmental data, a standardised framework is required. life-cycle-analysis-graphic

LCA may be utilised for several purposes:

* To identify opportunities to improve the environmental aspects of a product and to find out the weak points in the product chain, where the changes are needed.

* For selection of relevant indicators of environmental performance.

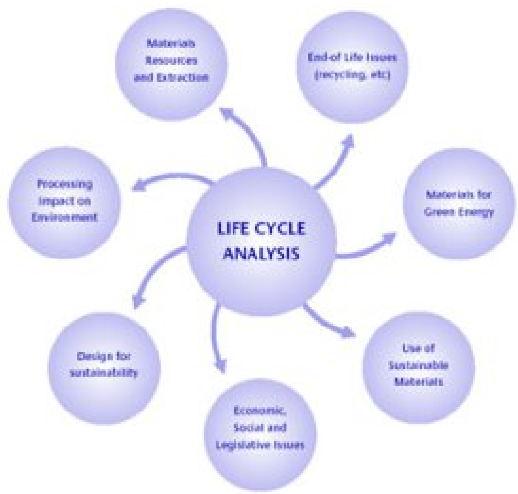
* For product development for environmentally better products.

* For decision making in governmental organisations.

* For product comparisons and product selections.

* For development of specifications, regulations or purchase routines.

* For marketing



The European Union has selected LCA method as one of the “official” methods for environmental evaluation. Also the European standardisation organisation, CEN, has highlighted the importance of the environmental aspects. CEN recognises that every product has impact on the environment during all phases of its life and it has started a system, where each new product standard is attached with a temporary environmental annex. For this annex life cycle assessment is a central tool.

LCA methodology and ISO 14 040 series

Standardisation of LCA methodology is under preparation. The fi rst two standards in the ISO 14 040 series have already been published and the two others are under debate. The standards are:

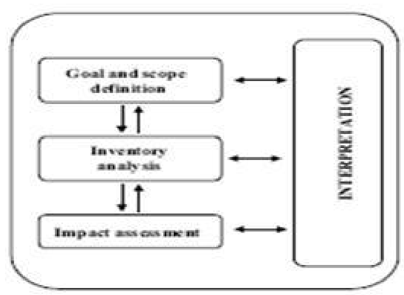
* ISO 14 040 Life cycle assessment – Principles and framework.

* ISO 14 041 Life cycle assessment – Goal and scope defi nition and inventory analysis.

* ISO 14 042 Life cycle assessment – Life cycle impact assessment.

* ISO 14 043 Life cycle assessment – Life cycle interpretation.

The LCA method can be divided into three basic steps: goal and scope definition, inventory analysis and impact assessment as illustrated below.



Life Cycle Assessment framework according to ISO 14 040

The methodology for the two first steps is relatively well established while the third step of impact assessment is more difficult and controversial. Goal and scope definition and inventory analysis are usually referred to as the Life Cycle Inventory or LCI. This part of study can be done separately without impact assessment. If the inventory part of the study is not driven to the final disposal, but to a certain stage of the product life cycle, for example polymer pellets at the factory gate, the study is called as a partial life cycle inventory or eco-profile. This is what many of the producers prepare from their own product, because the product route is known and managed by the producer to this point. The user of the product may further build on the eco-profile and calculate his own eco-profile depending on his specific application.

The first step in the LCA method is the goal and scope definition. The goal definition states clearly the intended application of the study, the reasons for carrying out the study and the intended audience.

For the scope the following items should be clearly described:

* The product system to be studied.

* The functional unit.

* The product system boundaries.

* Allocation procedures, assumptions made and limitations.

* Data requirements.

The second step in the LCA method is the inventory analysis, which involves data collection and calculation procedures to quantify inputs and outputs of the system. These inputs and outputs are the use of natural resources e.g. raw materials, use of energy and emissions to air, water and soil. The life cycle inventory must be clearly described and the system must be transparent.

The third part of the life cycle assessment, impact assessment, is qualitative by nature. It is difficult and the methodology is still under development. At this stage the process followed is to evaluate the significance of environmental impacts by associating inventory data with specific environmental impacts and attempting to understand those impacts. But there are no generally accepted methods for associating inventory data with specific environmental impacts. So this part of the process is generally not included in environmental impact assessments.

Life cycle assessment studies are always iterative processes, where interpretation of the results is done all the time. This may have an effect on the earlier parts of the study, which may be revised based on later findings. Findings in the interpretation phase may also lead to conclusions and recommendations to take improvement actions. Directly the LCA process does not give any final answers or improvement plans. Normally the result of the LCA process is one of many factors affecting a final purchasing decision like technical performance, economic and social aspects.

Summary of the procedure of LCA

Life-cycle assessment is the most standardized and quantified evaluation methodology of those compared. The evaluation typically proceeds as follows:

* Goal and scope definition. This includes the purpose of the study, the system boundaries, and the functional unit of comparison. A material and energy flow chart is also mapped.

* Life-cycle inventory (LCI). In this phase, all information on emissions and the resource consumption of the activities in the system under study are catalogued.

* Life-cycle impact assessment (LCIA). In this phase, the environmental consequences of the inventory are assessed and sensitivity analyses of the results are developed. This typically includes aggregation of the inventory into impact categories (Table 1).

Table 1: LCA Impact categories

Typical Impact Categories
Depletion of abiotic resources
Depletion of biotic resources
Impacts of land use
Climate change
Stratospheric ozone depletion
Human toxicity
Ecotoxicity
Photo-oxidant formation
Impacts of ionizing radiation
Acidification
Eutrophication

* Interpretation. This fourth but controversial step occasionally included by some LCA methods is the interpretation of the results, which may include normalization, weighting and/or additional aggregation.

Discussion – Comparison of LCA with Environmental Impact Assessment (EIA) –

Environmental impact assessment is generally a more familiar method in the US, as it is often a bureaucratically required process used to insure that environmental and other non-monetary concerns are considered in the process of planning government funded or regulated projects. EIA is a process of identifying, predicting, evaluating, and mitigating the biophysical, social, and other relevant effects of proposed projects or plans and physical activities prior to major decisions and commitments being made.

* The primary difference between environmental impact assessment and life-cycle assessment is that EIA is a framework for conducting assessments, not a precise method for analysis. For most practical purposes, LCA is associated with specific methods of analysis. Within EIA there are no assigned or standardized categories or methods of analysis for those categories.

* This difference is due to differences in the scope of assessment between EIA and LCA. EIA generally addresses more localized impacts and allows for the most appropriate methods for the uniqueness of the site and significant impacts. The standard LCA methods, on the other hand, are virtually incapable of detailing most local impacts, but generally provide the most reliably complete quantification of net environmental impact from a regional or global perspective.

Source : http://saferenvironment.wordpress.com/2009/11/06/life-cycle-assessment-lca-a-tool-for-quantifying-sustainability-and-sound-methodology-for-describing-environmental-impacts/