

THE INCREASING IMPORTANCE OF ENVIRONMENTAL THINKING THROUGH LIFE CYCLE ASSESSMENT

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Introduction

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. This is our license to operate.

For our industry to be successful in the future it must demonstrate that it understands the environmental impact that it makes.

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

The purpose of this paper is to describe this methodology and to report on the actions which EAPA and Eurobitume have taken to provide a tool to fulfil the following objectives:

- 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

What is Life Cycle Assessment?

Life cycle assessment [LCA] is a relatively new technique, which aims to account for the environmental burdens created by a product or a service throughout its whole life cycle – “from cradle to grave”. 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.

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

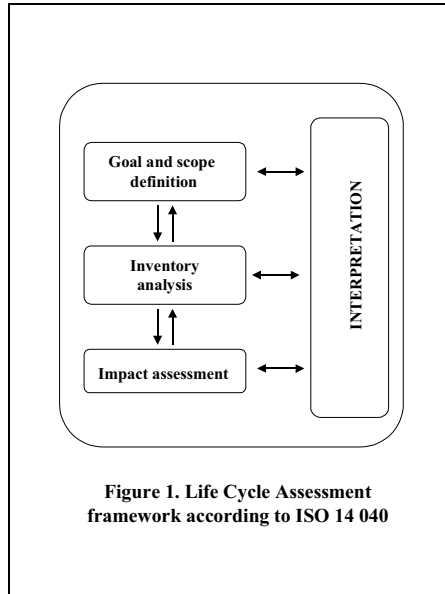
The European Union has selected LCA method as one of the “official” methods for environmental evaluation. Also the European standardisation organisation, CEN, has highlighted the importance of the environmental aspects. CEN recognises that every product has impact on the environment during all phases 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 first 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 definition 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 in figure 1.



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 know 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.

Life cycle assessment studies made on asphalt pavement

There have been two LCA studies made on asphalt pavement, namely a Swedish IVL study from 1995 financed by the Swedish Road Authorities and a Finnish VTT study from 1996 financed by cement industry. The Finnish study was a direct comparison between asphalt and concrete pavements. The Swedish study included a comparison, but this was not the main point of the study. Both the studies gave in principle similar results about the comparison although the scope and the assumptions were different.

Table 1 Comparison of the scopes of the IVL- and VTT-studies on asphalt pavement

	IVL-study	VTT-study
Functional unit	1 km road	1 km road
Pavement width	13 m	8,5 m
Construction	Asphalt 8 cm Base course 1,5 m Stabilised soil	Asphalt 24 cm Base course 1,9-2,5 m
Traffic	ADT 5 000 Not included	ADT 20 000 Included
Time period	40 years	50 years
Lighting	Included	Included
Construction work	From virgin land to final road	Base course and pavement
Operation	Sanding & salting Snow ploughing Grass cutting Ditch maintenance Traffic sign cleaning etc.	Salting
Maintenance	Six operations/40 years	Six operations/50 years

The results from the comparison between asphalt road and concrete road are rather good for asphalt (see below in figure 2). Asphalt construction showed lower figures in almost all the major emissions and energy use. Street lighting has a large effect on the total energy consumption and this may effect on the conclusions made from the different studies.

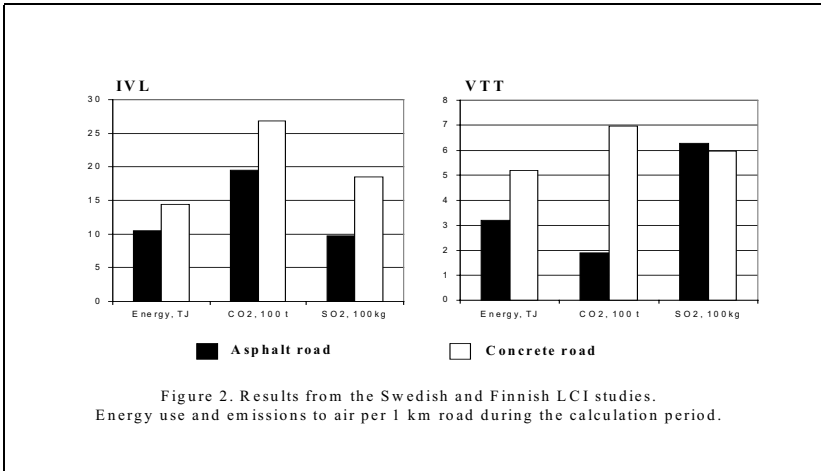


Figure 2. Results from the Swedish and Finnish LCI studies.
Energy use and emissions to air per 1 km road during the calculation period.

When comparing the impact of the pavement or the whole road construction with the impact of the traffic moving on the road during the whole time period, we can say that the traffic makes 95...99 % or even more of all the emissions and energy use. So if we can diminish traffic emissions by a few percent by having a better pavement we have made an environmental improvement.

Inventory Analysis for Bitumen the eco-profile

Eurobitume started as one of the first producer organisations in the oil sector to do life cycle assessment studies. Bitumen producers saw clearly the increasing importance of environment for modern society. Customers needed an environmental evaluation of bitumen for the calculations of their own products. Also authorities and official organisations started to ask for environmental data about the products. Therefore Eurobitume started a project with all the bitumen producers to make an eco-profile for a typical European paving grade bitumen. The reasons for making an average profile and not to have tens of different profiles were several:

- To involve all the producers in the process and to teach the LCA methodology.
- To have the same methods and principles when making eco-profiles.
- To save resources, especially at the data collection stage.
- To prevent unsound competition with eco-profiles made with different principles.

The project took several years and it was a long learning process. One of the major difficulties was to get relevant data and when data is available to determine how accurate and representative it was. Figure 3 illustrates the system boundaries for the project.

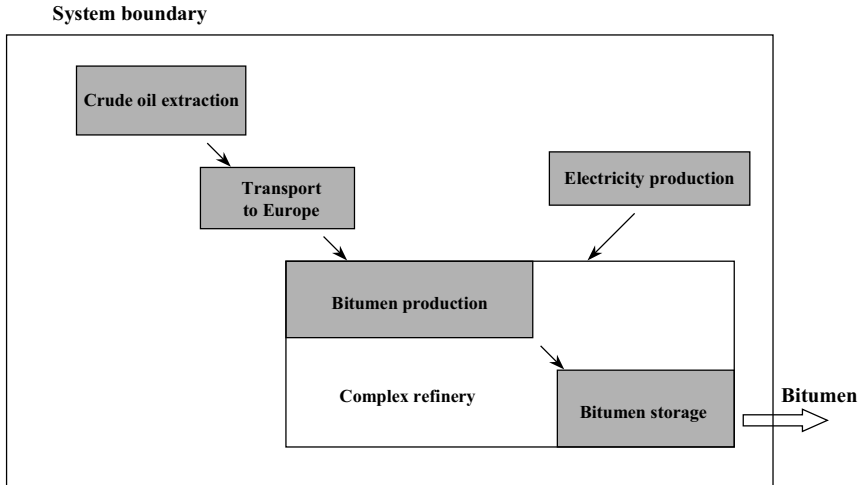


Figure 3. Flow chart and system boundary for bitumen eco-profile study

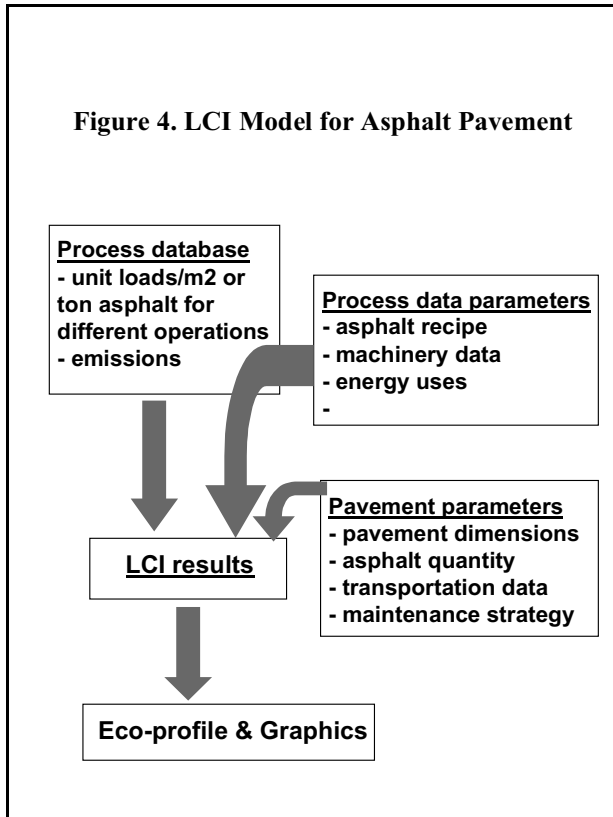
EAPA and Eurobitume joint study on asphalt LCI

EAPA and Eurobitume started a joint LCI study for an asphalt pavement in 1998. The project has been performed by the Swedish Environmental Research Institute. The target of the study is:

- To develop a computer model for LCI calculations.
- To collect base data from the paving process for the companies for their own calculations.

During the project a computer model based on a Microsoft Excel calculation tool was developed. With this new tool life cycle inventories of different road constructions and maintenance operations can be calculated. The flexibility of the system is very large and it covers typical main operations in the European practise. The user can use his own specific base data when doing inventories.

The tool can be used easily by a LCA expert, because the system contains asphalt data needed. The tool can also be used easily by an asphalt expert, because the system contains also a huge amount of environmental data. The user may accept the typical data suggested or he may select a more suitable data for his case from the data database or he may use his own data if that is available. The computer tool will be ready and available for the EAPA and Eurobitume members at the end of this year.



The model illustrated above in figure 4 contains three databases and calculation algorithms. Pavement parameters contain the specification of the studied pavement like pavement area, asphalt quantity, maintenance operations during the calculation period. Process parameters contain energy uses and emissions from different engines and recipes of asphalt, with this data process database is calculated. In the process database there are energy uses and emissions from different operations per produced asphalt ton or laid asphalt m². Then LCI results are calculated and some graphics are automatically drawn to help to demonstrate the result.

The calculation model includes environmental data from materials needed and from the following asphalt operations:

- Asphalt mixing, hot and cold
- Transportation
- Adhesive layer application
- Asphalt laying
- Asphalt rolling
- Asphalt pavement milling
- Reshaping
- Sealing
- Remixing
- Reclaimed asphalt processing

The new computer tool will help producers to study closer their own specific paving projects and it makes possible to compare alternatives for a better environment.

Summary

The general public and public authorities increasingly express concerns and 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.

The European Union has selected the Life Cycle Assessment methodology as one of the “official” methods for environmental evaluation

EAPA and Eurobitume have developed a new tool which will help industry to study closer specific paving projects and make it possible to compare alternatives for a better environment.

Literature

Håkan Stripple, Livscykelanalys av väg, IVL Swedish Environmental Research Institute Ltd, November 1995.

Tarja Häkkinen, Kari Mäkelä, Environmental adaption of concrete – environmental impact of concrete and asphalt pavements, VTT Building Technology, 29.3.1996.

Eurobitume, Partial life cycle inventory or “eco-profile” for paving grade bitumen, Report 99/007, May 1999.

The increasing importance of environmental thinking through life cycle assessment by Timo Blomberg

**EURASPHALT & EUROBITUME Congress
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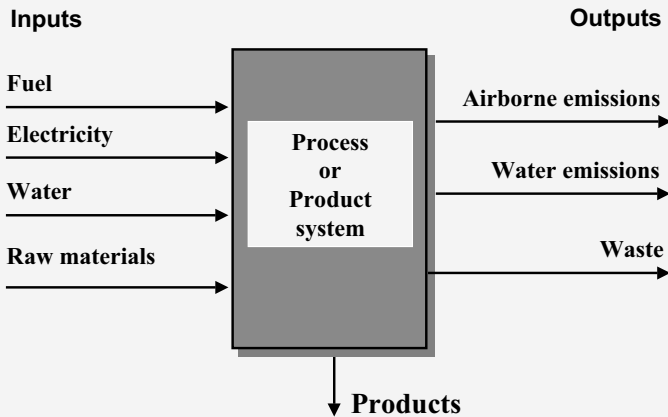
What is LCA?

Life Cycle Assessment:

**Accounts the environmental loads created by a
product or a service throughout its whole life
cycle**

“from cradle to grave”

Simplified eco-balance



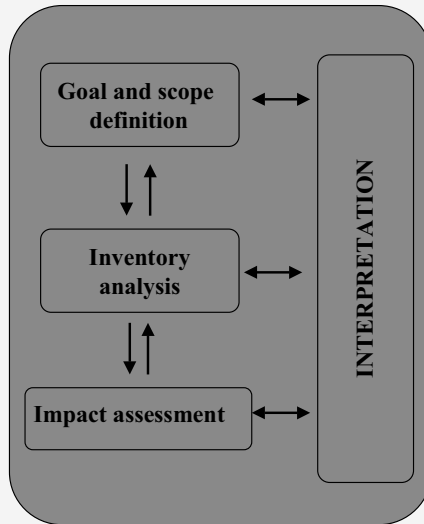
ISO 14 040 series for LCA

ISO 14 040LCA - Principles and framework

**ISO 14 041LCA - Goal and scope definition
and inventory analysis**

ISO 14 042LCA - Life cycle impact assessment

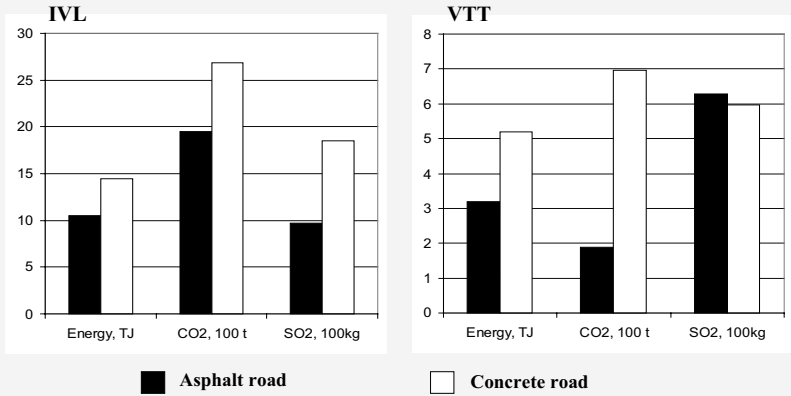
ISO 14 043LCA - Life cycle interpretation



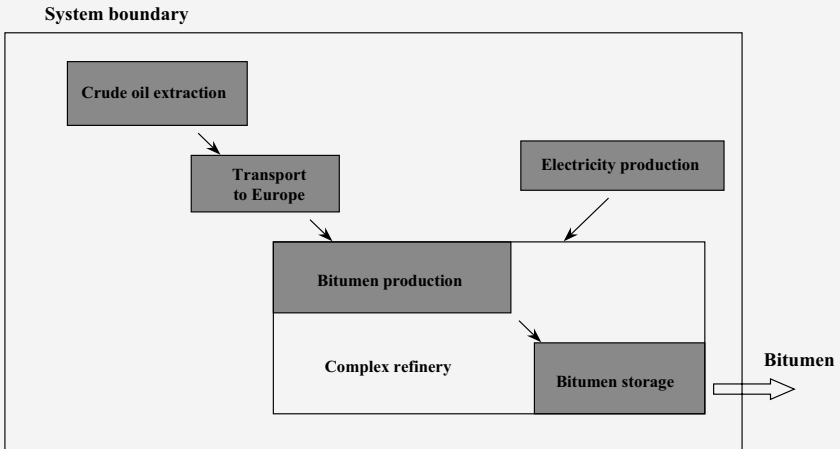
Life Cycle Assessment framework according to ISO 14 040

Comparison of the scopes of IVL- and VTT-studies

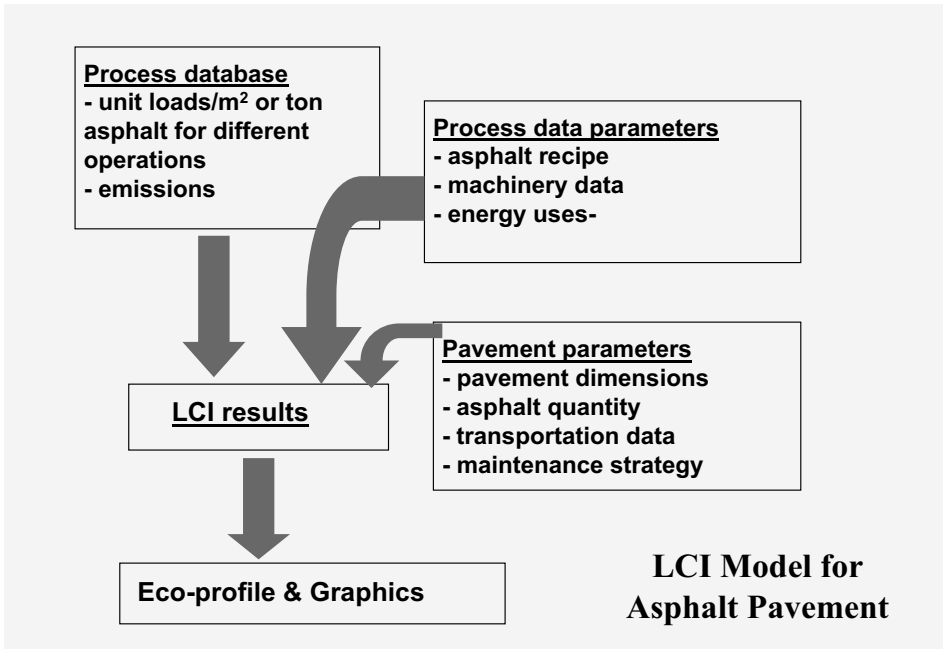
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Results from the Swedish and Finnish LCI studies.
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Flow chart and system boundary for bitumen eco-profile study



EAPA/Eurobitume Joint Study

- **The Result:**

A tool to assess environmental impact