

Material Flow Analysis And Life Cycle Assessment



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4th Unit: LCA - Overview Goal and Scope

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4th Unit: Life Cycle Assessment – Overview Goal and Scope Definition

- 4.1 Development of Life Cycle Assessment (LCA)
- 4.2 Overview of LCA Methodology
- 4.3 1st Phase: Goal and Scope

First „modern Life Cycle Analysis“



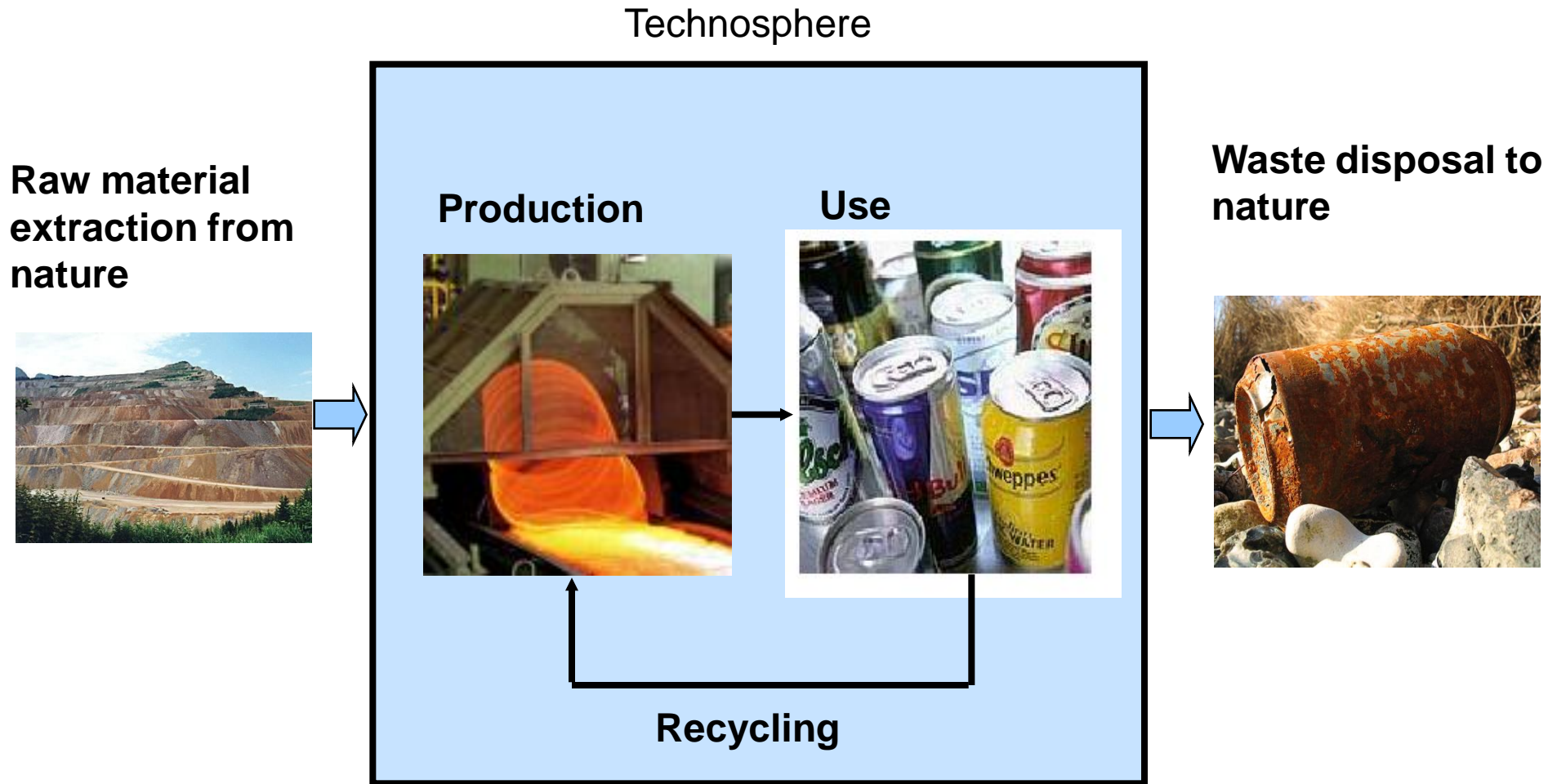
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1969-1970:

Resource and Environmental Profile Analysis on behalf of Coca-Cola

- It included the material flows as well as the energy flows for the production, use and disposal of beverage packaging
- It was carried out by the Midwest Research Institute in the U.S.
- The study was never published because it contains confidential information

The life cycle of products



Short History of Life Cycle Assessment



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1970ies:

- Early studies on packaging, waste, energy (US, Germany, Switzerland): „Ökobilanzierung“, „Ecobalances“, „Resource and Environmental Profile Analysis (REPA)“, „Integral Environmental Analysis“, „Environmental Profiles“, „Life Cycle Analysis“

1980ies:

- National projects on LCA (data bases and methodology);
- LCA in industry for marketing - criticism on „greenwashing“;
- Interest in LCA decreasing

Short History of Life Cycle Assessment

1990ies:

- Scientific approaches on methodology (SETAC, CML)
- From 1993: TC207 (Working Group International Standardization Organization)
- 1997: first ISO Standard:– 14040 LCA – Principles and Framework

2000ies:

- Policies based on „Life Cycle Thinking“ (EU Intergrated Product Policy, Waste Policy, Resources Policy)
- 2006: amendment of ISO Standards – current standards on LCA: ISO 14040 and ISO 14044

Standards for LCA:

DIN EN ISO 14040

Environmental management –

Life cycle assessment – Principles and framework (ISO 14040:2006)

DIN EN ISO 14044

Environmental management –

Life cycle assessment – Requirements and guidelines (ISO 14044:2006)

The Standardisation as a Framework

- Standardisation is the general framework, but does not regulate details.
- Standardisation is the basis for practical application as well as for instruments with legal status.
- The methodology described in the standardisation creates transparency and reproducibility.
- As a research tool in science, the life cycle assessment goes beyond the standardisation.

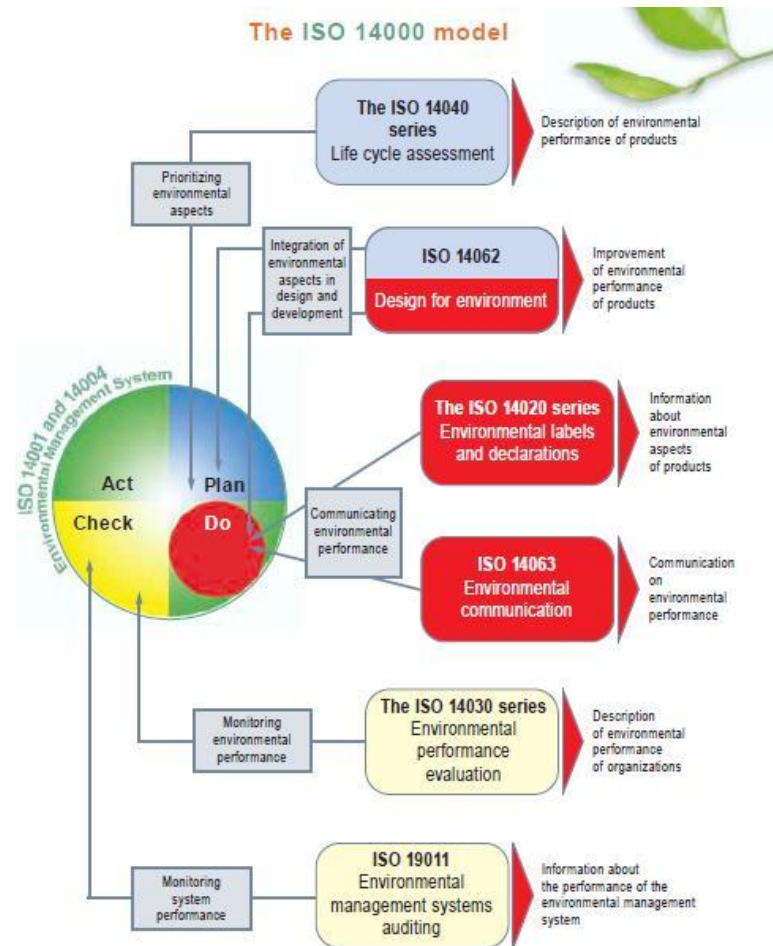
ISO 14000 Family of Standards

- ISO 14000 is a series of international, voluntary standards for environmental management of companies. It is developed by ISO Technical Committee 207 (www.tc207.org)
- The ISO 14000 family of standards is divided into standards that cover the management of organizations and into standards that cover the life cycle of products.

They include the following aspects of environmental management:

- Environmental Management Systems (EMS)
- Environmental Auditing & Related Investigations (EA&RI)
- Environmental Labels and Declarations (EL)
- Environmental Performance Evaluation (EPE)
- Life Cycle Assessment (LCA), and
- Terms and Definitions (T&D)

ISO 14000 family of standards



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Basics of Life Cycle Assessment according to ISO 14040/ISO 14044

The LCA is a methodological tool to study the environmental impacts of products, services and processes throughout the entire life cycle.

Main ideas are:

- System oriented approach
- Relative statements relative to a reference value (no absolute statements)
- Environmental cross-media acquisition of the environmental effects (air, water, soil)
- Transparency and objectivity by modular approach

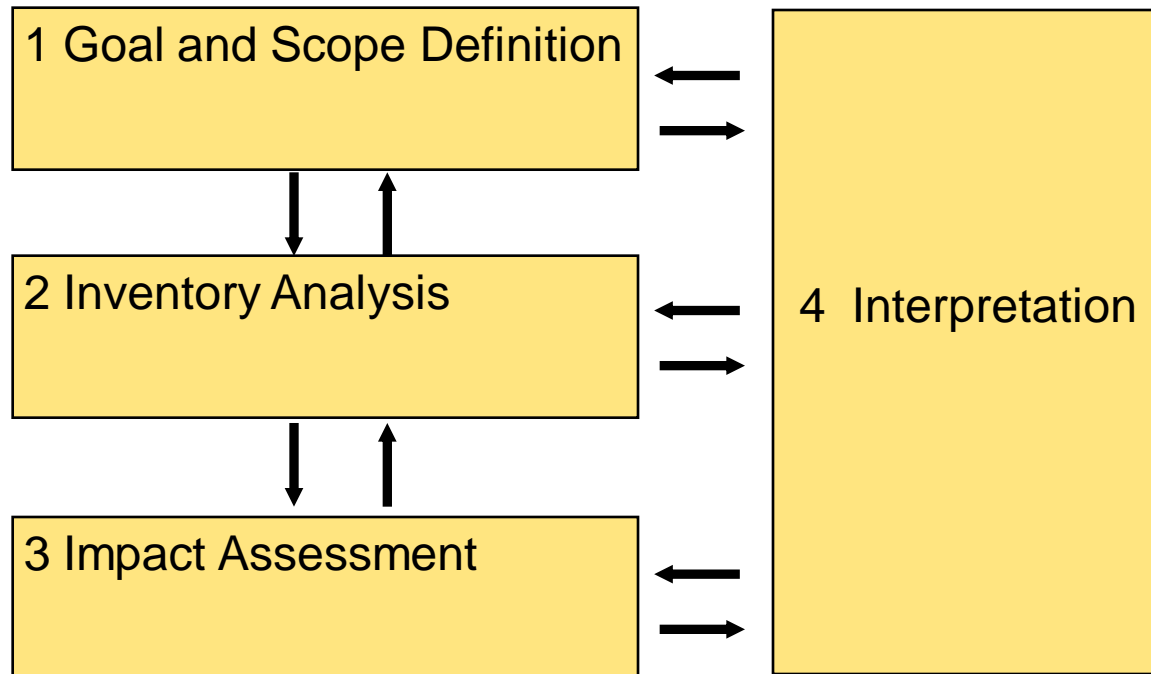
Applications of Life Cycle Assessment

Life Cycle Assessment is suitable for:

- the demonstration of potential to improve the environmental performance of products, processes and services
- providing decision guidance for industry, governments, non-profit organisations as well as for the environmental product declaration
- illustration of complex relationships

Elements of Life Cycle Assessment

Structure of a LCA (according to DIN ISO 14040 and 14044)



Elements of Life Cycle Assessment



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Goal and Scope

- Systems boundary
- Methodological Choices and Organizational framework of study

Inventory Analysis

- „Material flow Model“

Impact assessment

- Evaluation of Environmental relevance of material flows

Interpretation

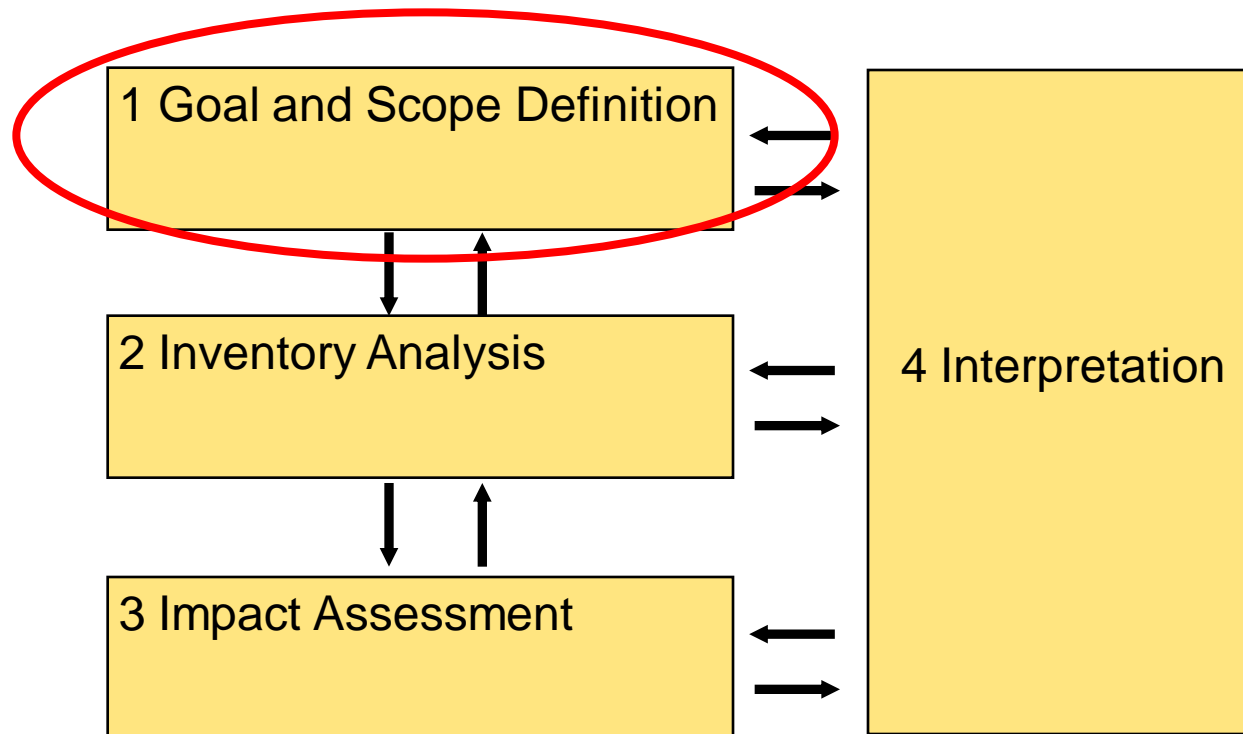
- Validation and Explanation

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Elements of Life Cycle Assessment

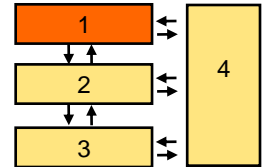
Structure of a LCA (according to DIN ISO 14040 and 14044)



Goal and Scope

- Important Determinations

The **goal** of a LCA study must clearly define its intended application as well as list the target groups.



The most important determinations of the scope are:

- the **function** and the **functional unit** of the object of investigation;
- the **system boundaries** (spatially and temporally), the assumptions, the cut-off criteria;
- the selection of **impact categories**;
- the requirements of **data** and their **quality**.

The description of the goal of an LCA includes:

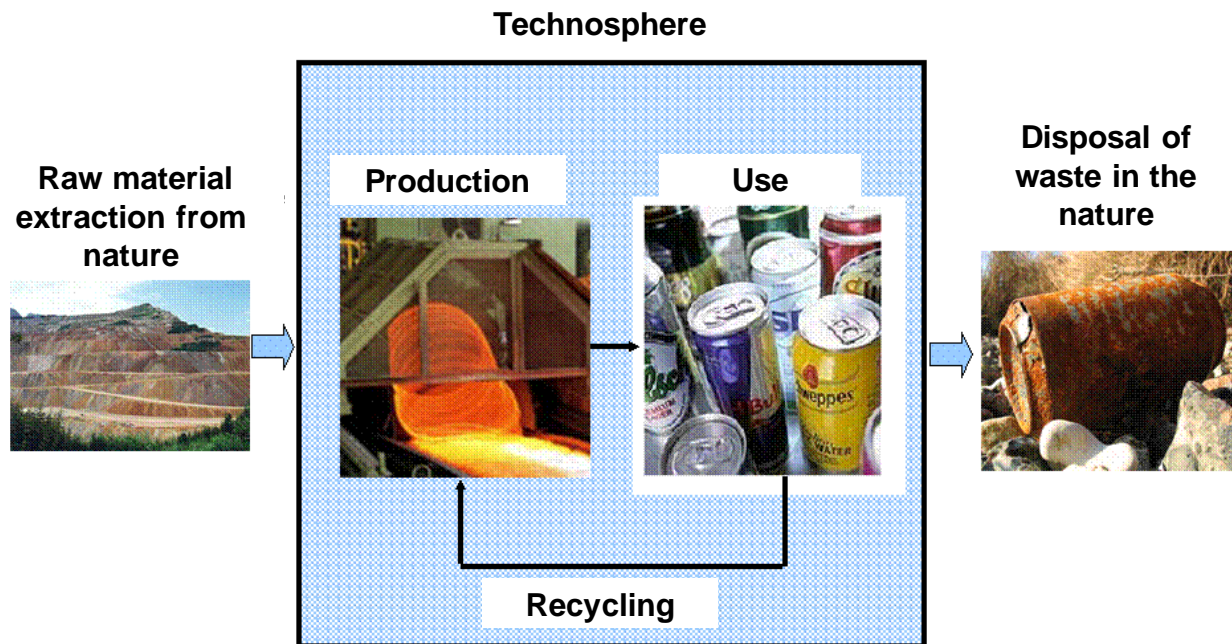
- the intended application
- the reasons why the study is carried out,
- the proposed applicants, i.e. to whom should the results be communicated
- if the results will be used for **comparative** statements that are provided for publication.

System boundaries can be described by several specification:

- Boundaries within natural systems
- Geographic boundaries
- Temporal boundaries
- Boundaries within the technical system

Boundaries within Natural Systems

Where does the life cycle start, where does it end?
→ General: Start/End of the human control



Stages of the Life Cycle of Products

The complete life cycle of products includes the stages:

- Production
- Use
- Disposal

Sometimes only parts of the life cycle are recognized.

The following terms are common:

- From gate to gate: company balance
- From cradle to gate: manufacturing stage
- From cradle to grave: complete life cycle

Different stages of the life cycle take place in different parts of the world. This may inter alia be relevant for the following reasons:

- The infrastructure varies regionally, for example: electricity, waste management
- The reactions of the environment varies with the geographic location

Temporal Boundaries (I)

Temporal dissociation in view of :

- Accounting period
- Duration of the life cycle of a product
- Duration of possible effects on the environment

- **Accounting period** : based on practical constraints and data availability – for example: 1 year as a usual accounting period of a company.
- **Life cycle of a product**: For long-lived products the temporal boundary includes longer periods in the future – Example: Buildings.
- **Effects on the environment**: Decision whether environmental effects with very long durations are considered – Example: Landfilling of waste.

Temporal Boundaries (II)

Fundamental difficulties in defining temporal system boundaries:

- Processes in the future (e.g. recycling) can be crucial to the results of a LCA.
- Long time horizons are associated with great uncertainty because of a lack of knowledge about the future.
- Will environmental effects in the future be evaluated as they are in the present?

- **Functional unit:**

Quantifies the function and thus the value of a product (a service, a process) and forms the reference value of a LCA.

- All input and output flows of the system are related to it.

- **Reference flow:**

the reference flow is the amount of product that is needed to provide this value.

Example Beverage Packaging

Variants for milk packaging:

- returnable bottles
 - Tetra Pak
 - pouch
-
- Functional unit: Packaging of 1000 l milk
 - Reference flows:
 - 100 returnable bottles or
 - 1000 Tetra Pak or
 - 1000 pouches

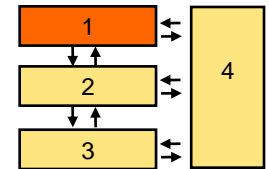


Match of the Functional Unit and Reference Flow

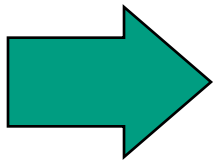
For certain objectives, the functional unit and the reference flow match. Example: : Manufacturing of a product „cradle to gate“

- Possibility of demarcation:
- Functional unit: Provision of 1 unit of the product at the factory gate
- Reference flow: 1 production unit

Difficulties in Defining the Intended Use and the Functional Unit



- No testing requirements of the intended use available
- Different opinions on the type and fulfilment of the utility value of processes and products are possible



Remedy :
e.g. by project-related groups and consensus

Impact Assessment and Impact Categories

Impact Assessment

- "The selected impact categories, the method for assessing the impacts and the method of the subsequent evaluation have to be determined" (ISO 14040)

Impact Category

- Class that represents important environmental issues and to which the LCI results can be assigned
(ISO 14040)



An impact category represents an environmental problem:

Example:

The problem climate change is represented by the impact category "global warming"

Determination of the Impact Categories

- In the stage of impact assessment, the data on material flows collected in the inventory analysis are assigned to impact categories. Every impact category represents an environmental problem.
- Before the outset of a LCA study, it must be decided which environmental problems and therefore what impact categories are relevant for the issue. This decision is necessary at the outset of a study because the flows for which data have to be collected in the inventory analysis depend on the choice of the impact categories.