

Material Flow Analysis And Life Cycle Assessment



TECHNISCHE
UNIVERSITÄT
DARMSTADT

5th. Unit: LCA – Life Cycle Inventory Analysis (LCI) I

SoSe 2012

Prof. Dr. Liselotte Schebek
Fachgebiet Industrielle Stoffkreisläufe
Institut IWAR

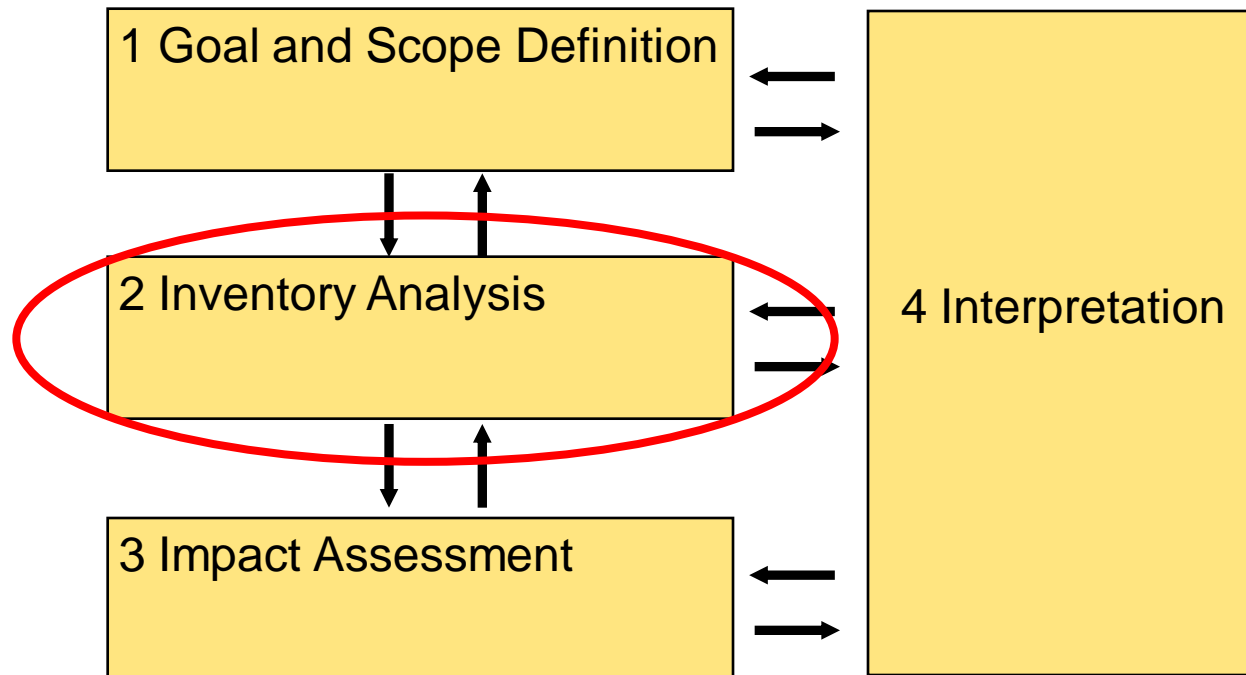


5th Unit: Life Cycle Inventory Analysis (I)

- 5.1 Overview of the Inventory Analysis
- 5.2 Description of the Product System
- 5.3 Data Collection

Elements of Life Cycle Assessment

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



5.3.1 General

- Life cycle inventories include data collection and calculation procedures to quantify relevant input and output flows of a product system.
- The process of creating a life cycle is **iterative**.
- While data are collected and the system is examined in more detail, new data requirements or restrictions could be identified which require a change in the process of data collection so that the goals can still be fulfilled.
- Sometimes circumstances are identified which require changes of the goal or the scope of the study.

Essential steps of the life cycle inventory:

- Creating a detailed flow sheet
- Data collection
- Calculation of the product system



5th Unit: Life Cycle Inventory Analysis (I)

- 1.1 Overview of the Inventory Analysis
- 1.2 Description of the Product System
- 5.3 Data Collection

Product system

= a **summarization of process modules** with elementary flows and product flows that models the life cycle of a product and that fulfils one or more **defined functions**.

(ISO 14040)

- Product systems are divided into **modules**
- Modules are interconnected with other modules by intermediate products and/or wastes, with other product system by product flows and with the environment by elementary flows.
- The product system is determined by its function and can not be defined only by the final product.

Definitions (I)

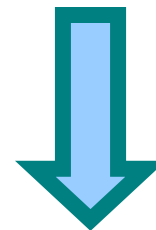
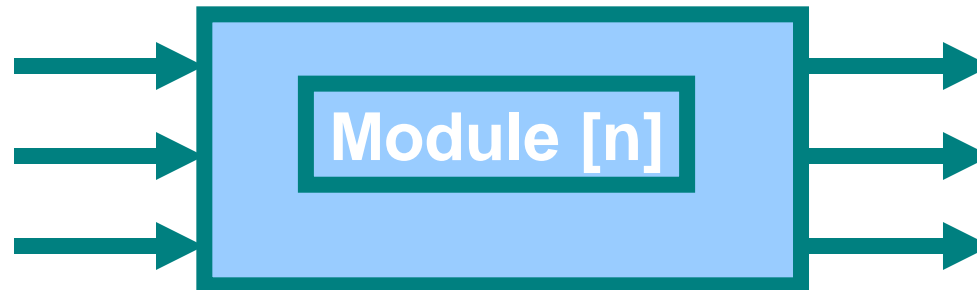
Product



Elementary flows
(on the output side)

e.g.

- Wastes
- Emissions
- Waste heat



Product

Elementary flows
(on the input side)

e.g.

- Raw materials
- Water
- Energy



Elementary flow

- Material or energy that was taken from the environment and which is **supplied** to the system under study **without previous treatment** by humans.

or

- Material or energy which **leaves** the system under study and is released into the environment **without subsequent treatment** by humans.



- **Process:** set of interrelated or interacting activities which transforms inputs into outputs.
- **Process module:** smallest component that is recognized in the life cycle inventory and for which input and output data are quantified.
- **Input:** product-, material- or energy flow that is supplied to a process module
- **Output:** product-, material- or energy flow that is released by a process module

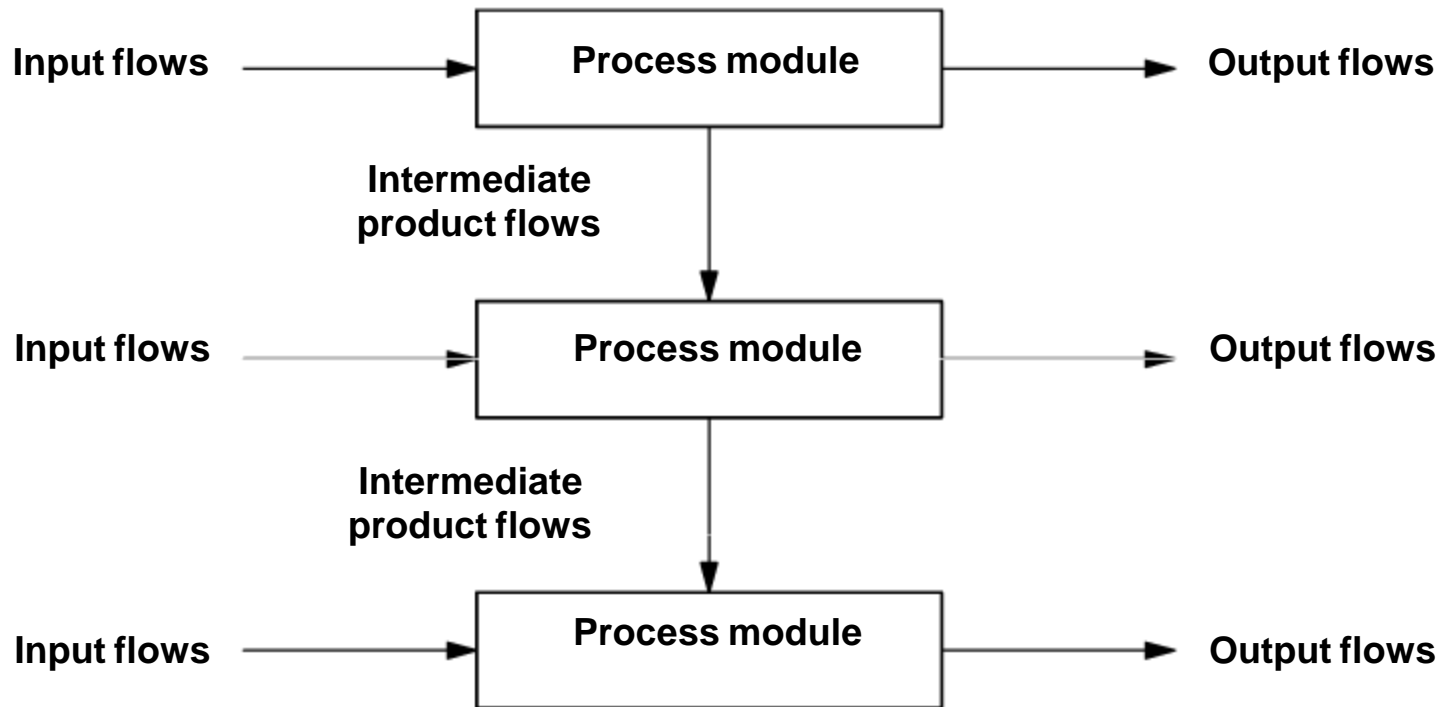


Figure 3 – Example of a set of product modules within a product system

Flow charts

- illustrate processes as boxes and flows as arrows;
- the real linkages between the processes within the product system are represented graphically

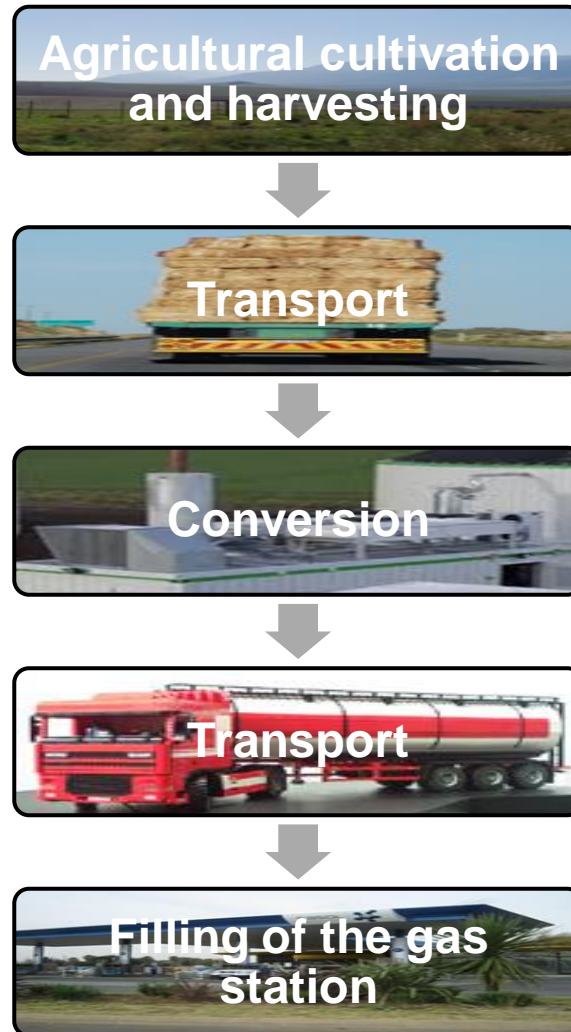
Flow charts are used

- for the conceptual understanding of the product system;
- as the basis for the collection and classification of data for the subsequent calculation of the flows.

Linear Flow Chart

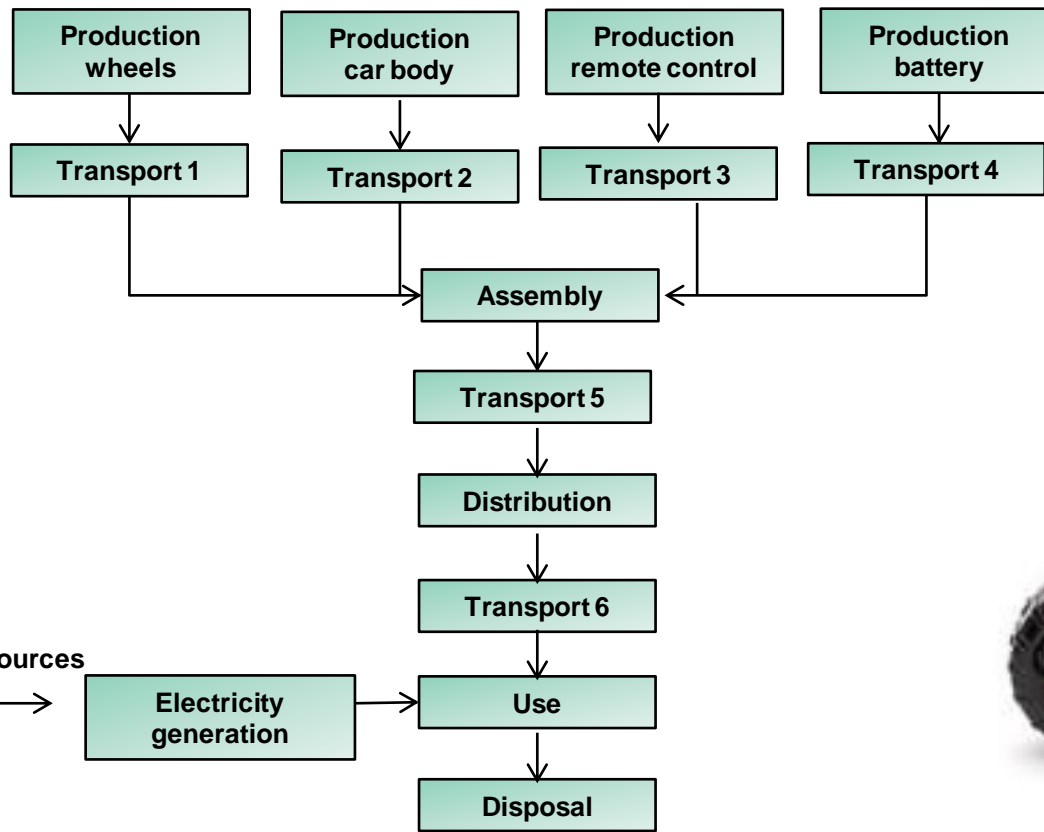


TECHNISCHE
UNIVERSITÄT
DARMSTADT

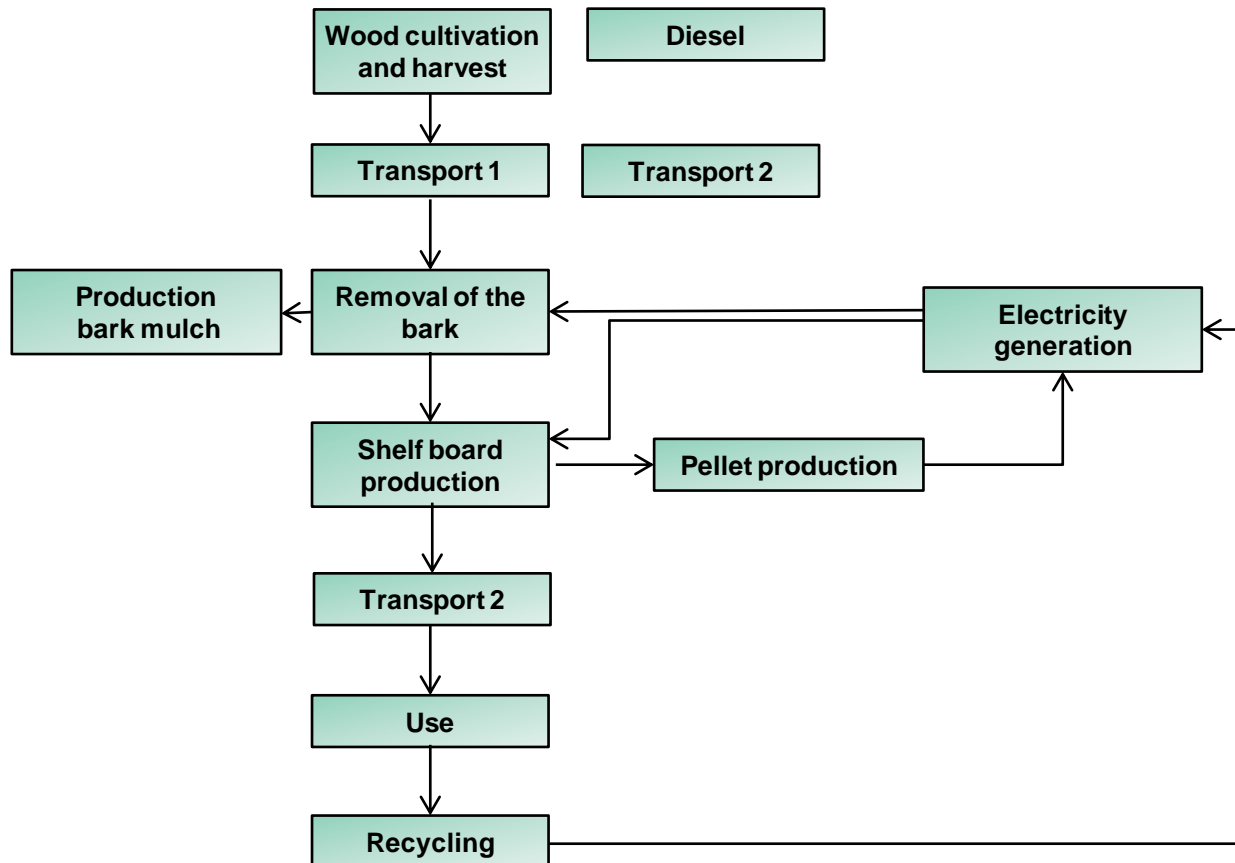


Example:
Production of biofuel

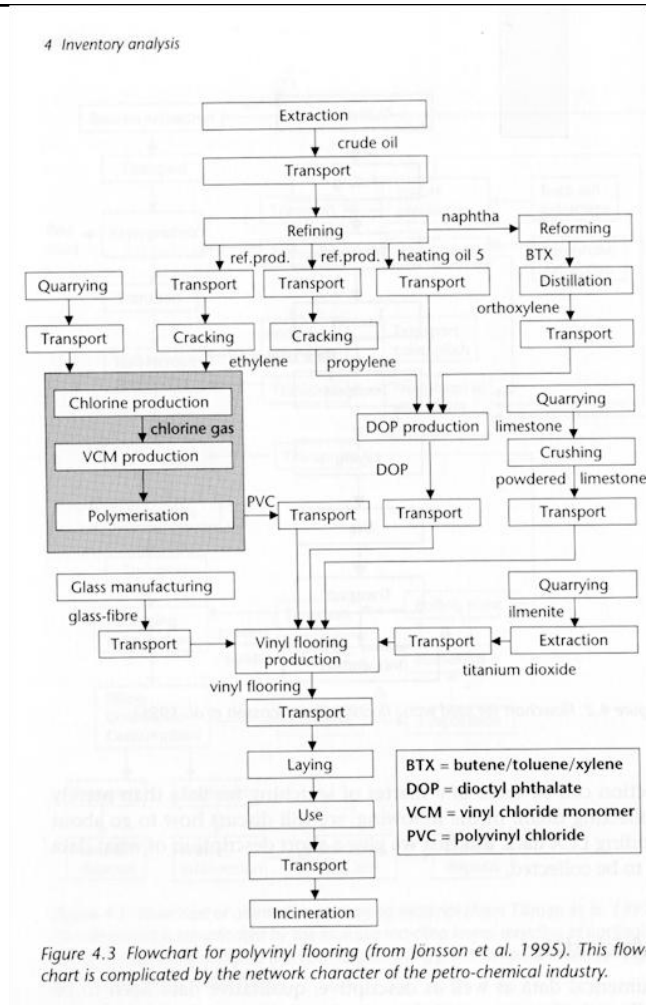
Flow Chart with Tree Structure



Flow Chart with Recycling Loops



Highly Cross-linked Flow Chart



Source: H. Baumann, A.-M. Tillman; The Hitch Hiker's Guide to LCA



5th Unit: Life Cycle Inventory Analysis (I)

- 5.1 Overview of the Inventory Analysis
- 5.2 Description of the Product System
- 5.3 Data Collection

Which Data are Required?

- Data on input and output flows for each process module related on its reference flow (“product“ of the process)

However:

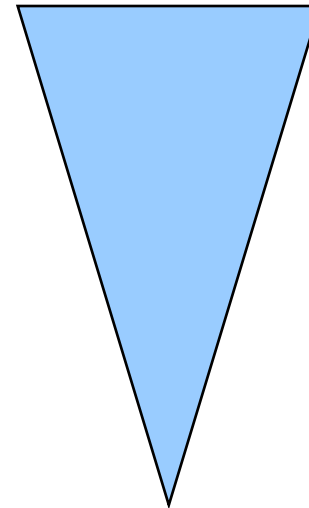
Data on flows aren't always available. In some cases, they must be determined on the basis of other information:

- Technical description of processes
- Consumption of materials and energy
- Transport distances
- Information on product use
- Recycling of products
-

Procedures for Data Collection

- Data collection (measure; estimate ...)
- Evaluation of literature
- Databases

Workload



Foreground system : preferably specific data / primary data

Background system: preferably databases

(quality assured, representative)

Collection of Specific Data



TECHNISCHE
UNIVERSITÄT
DARMSTADT

- Measurement on facilities, companies...
- Questioning (questionnaires, personal interviews ...)
- Evaluation of documents (e.g. environmental management, documentation of working papers, construction plans, data systems of companies ...)

=> Accessibility/confidentiality of documents?

=> Documentation of data and meta-information!

Data Sources in an Enterprise



TECHNISCHE
UNIVERSITÄT
DARMSTADT

- Bill of materials
- Invoices (for example raw materials or energy purchase)
- Company standards, operating procedures etc.
- Measurements
- Expert estimations

Collection of Operating Data



TECHNISCHE
UNIVERSITÄT
DARMSTADT

A.4 Example of data sheet for unit process

| | | | | |
|---|--------------|---------------------|---|--------------------|
| Completed by: | | Date of completion: | | |
| Unit process identification: | | Reporting location: | | |
| Time period: Year | | Starting month: | Ending month: | |
| Description of unit process: (attach additional sheet if required) | | | | |
| Material inputs | Units | Quantity | Description of sampling procedures | Origin |
| | | | | |
| | | | | |
| Water consumption ^a | Units | Quantity | | |
| | | | | |
| | | | | |
| Energy inputs ^b | Units | Quantity | Description of sampling procedures | Origin |
| | | | | |
| | | | | |
| Material outputs (including products) | Units | Quantity | Description of sampling procedures | Destination |
| | | | | |
| | | | | |
| NOTE The data in this data collection sheet refer to all unallocated inputs and outputs during the specified time period. | | | | |
| ^a For example, surface water, drinking water. | | | | |
| ^b For example, heavy fuel oil, medium fuel oil, light fuel oil, kerosene, gasoline, natural gas, propane, coal, biomass, grid electricity. | | | | |

Bill of materials:

= a structured arrangement of objects

- A bill of materials is a structured arrangement of components or assembly groups that are required for the production of another component
- A bill of material arranges the parts of a system according to their structural properties
- Information from bills of materials are one of the most important data structures of companies thus materials are ordered or will be provided from the warehouse on this basis
- the completeness of a system delivered in pieces becomes verifiable by bills of materials

Validation of Data during Data Collection



TECHNISCHE
UNIVERSITÄT
DARMSTADT

Validation of data

- In the process of data collection a data validation must be performed to provide evidence that the requirements for data quality are met for the proposed application.
- The validation may include, for example, the creation of mass balances, energy balances and/or comparative studies of emission factors.
- Since each process module adheres the laws of conservation of mass and energy, mass and energy balances provide a useful tool for monitoring the validity of a process module description.
- When abnormalities in the data occur, alternative data must be found that meet the specifications of the data selection.

EN ISO 14044:2006 D/E