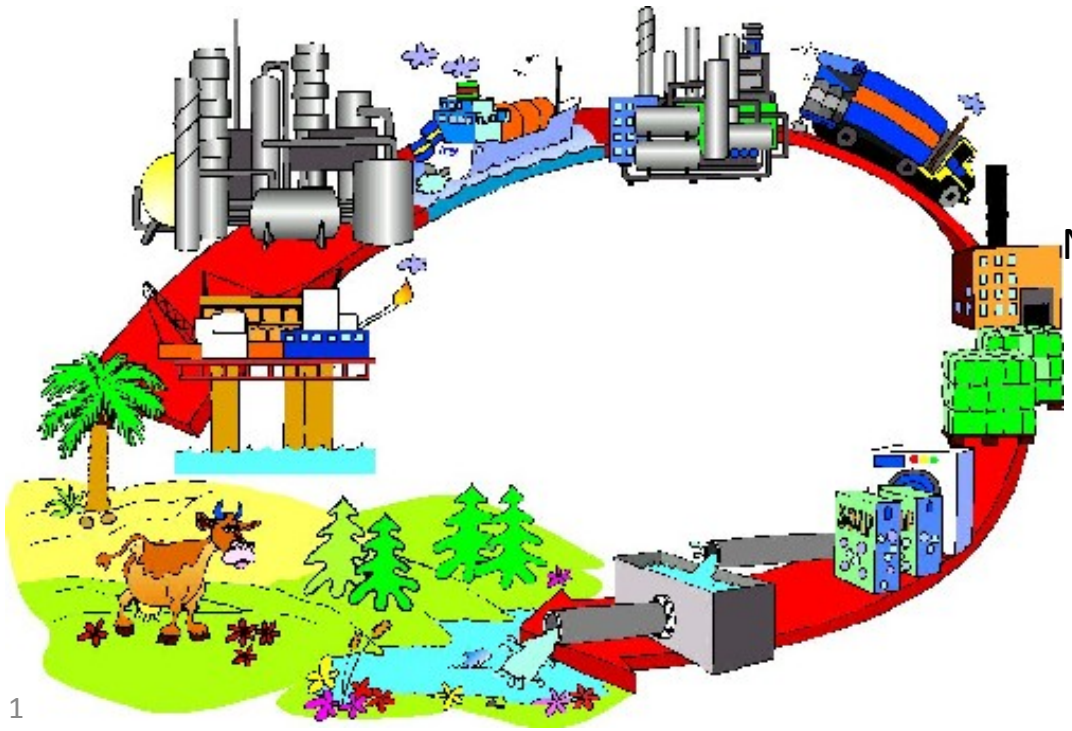
Environmental Life Cycle Assessment
PSE 476/WPS 576/WPS 595-005

Lecture 5: Goal and Scope:



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Goal definition

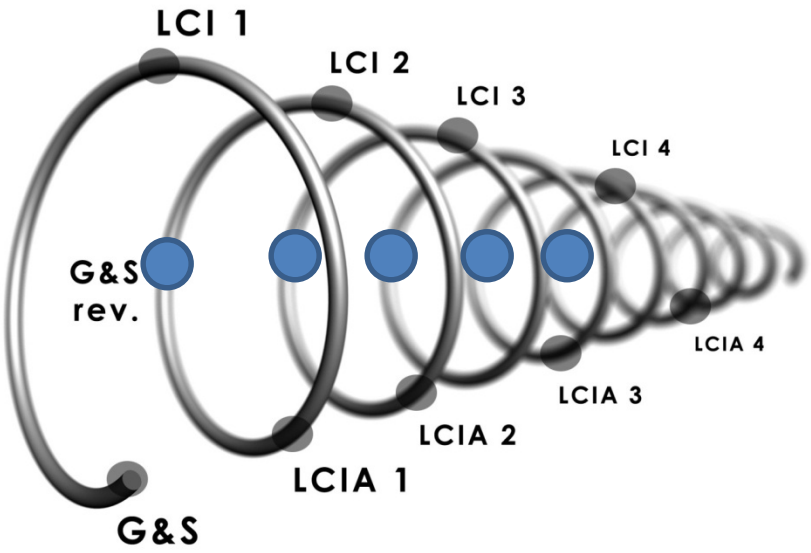
- Goal of study should unambiguously state (ISO 14044: 2006E):
  - The intended application
  - Reasons for carrying out the study
  - Intended audience (who will the LCA be communicated to?)
  - Whether the results are intended to be used in **comparative assertions** intended for the public
    - **Comparative assertion:** environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function.

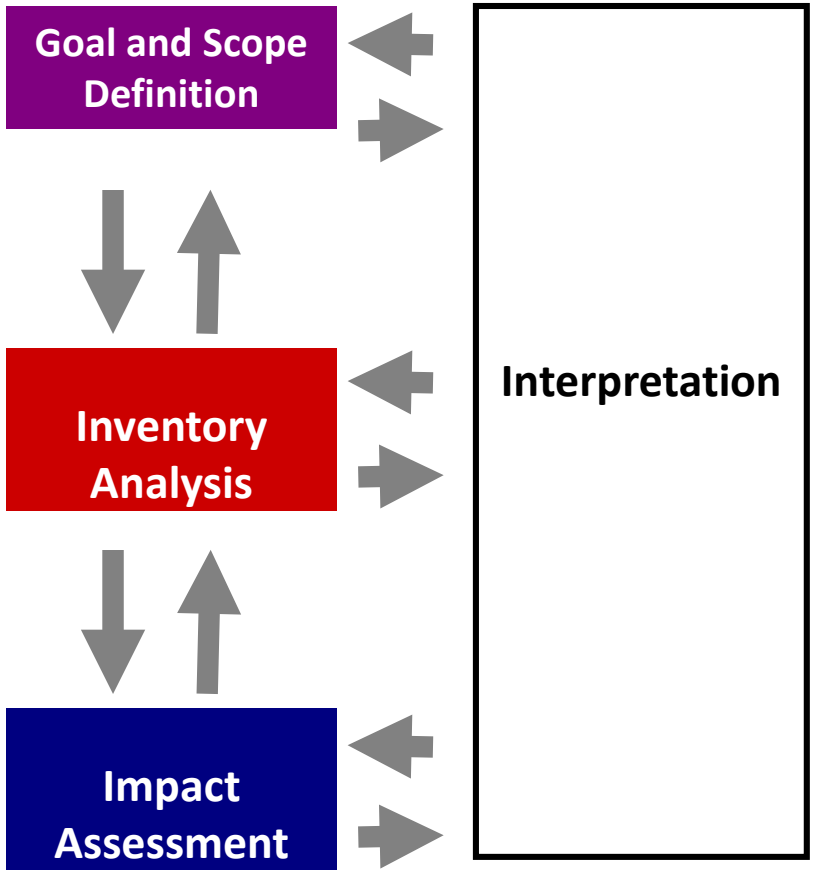
Goal definition

- **Goal:** Reasons for carrying out the study
  - ID opportunities to improve the environmental performance of products at various points in their life cycle
  - Informing decision makers in industry government, non government organizations (NGO's)
    - Strategic planning, priority setting, product or process design or redesign
  - Selection of relevant indicators of environmental performance, including measurement techniques
  - Marketing
    - Environmental claims
    - Eco labeling
    - Environmental product declaration

Refs: ISO 14044: 2006E

Goal definition





Scope

- Project Scope "The work that needs to be accomplished to deliver a product, service, or result with the specified features and functions.“

- A Guide to the Project Management Body of Knowledge (PMBOK Guide) - Fourth Edition. Project Management Institute, 2008. ISBN 978-1-933890-51-7

Scope definition

- Scope definition must be in accordance with the goal definition
- Scope definition should consider and clearly describe (ISO 14044: 2006E):
  - The product system studied
  - The functions of the product(s) studied
  - The functional unit
  - The system boundary
  - Allocation procedures
  - LCIA methodology and types of impacts
  - Interpretation to be used
  - Data requirements
  - Assumptions
  - Value choices and optional elements
  - Limitations
  - Data quality requirements
  - Type of critical review, if any
  - Type and format of the report required for the study

  - temporal scope
  - technological scope
  - allocation or system equivalency

Functional Unit and Reference Flows

- **Functional unit:** Quantified performance of a product system for use as a reference unit (ISO 14044: 2006E)
- Reference flow: measure of the outputs from processes in a given product system required to fulfill the function expressed by the functional unit

Time, gloss, color, opacity,

Functional Unit and Reference Flows

- Example: We are critically evaluating the environmental LCA of students having breakfast. We believe there are two options that we would like to study:
  - A bowl of cereal
  - A traditional eggs and meat breakfast

- What is the functional unit?

- What are the reference flow(s)?

Functional Unit and Reference Flows

- Example: We are doing an LCA on electrical room heaters. One heater has a lifetime of 4000 1 hour uses and puts out 100 BTU/h of heat. Another heater has a lifetime marketed as 10 years, using the heater used for 4 months, with 8 hours use each day and puts out 75 BTU/h of heat. Another heater claims to have a lifetime of 10 years putting out 25 BTU/hr with continuos use.

- What is a good functional unit?

- What are the reference flow(s)?

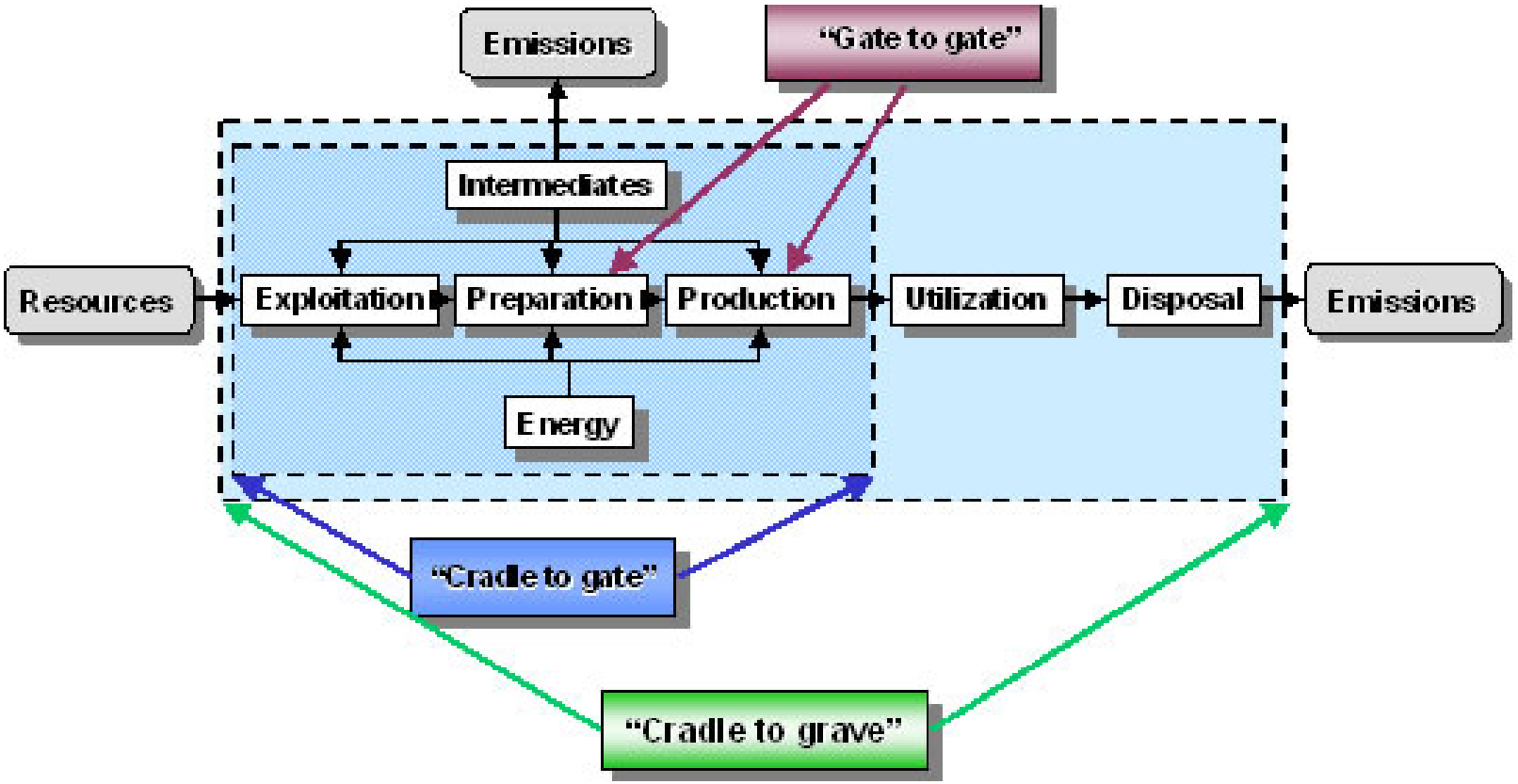
System Boundary

- Which unit processes are included in the LCA
- Must be consistent with the goal
- Deletion of a life cycle stage, process, inputs or outputs only permitted if it does not significantly affect the overall conclusions
- Any decision to omit must be justified

- Ideally, the system boundary so that inputs and outputs are all elementary flows and product flows

Refs: ISO 14044: 2006E

Different System Boundary Classifications:



http://www.steeluniversity.org/

Identify a system boundary for a laptop: Cradle to Gate, Cradle to Grave:

System Boundary

- Cut off criteria: specification of the amount of material or energy flow or the level of environmental significance associated with unit processes or product system to be excluded from the study
  - Mass, all the inputs that contribute less than X% to the total mass input of the product system
  - Energy, all the inputs that contribute less than X% to the total energy input of the product system
  - Environmental significance, any input that contributes less than X% of a the environmental significance of a specially selected environmentally relevant individual data
- Similar criteria for outputs

Refs: ISO 14044: 2006E

System Boundary

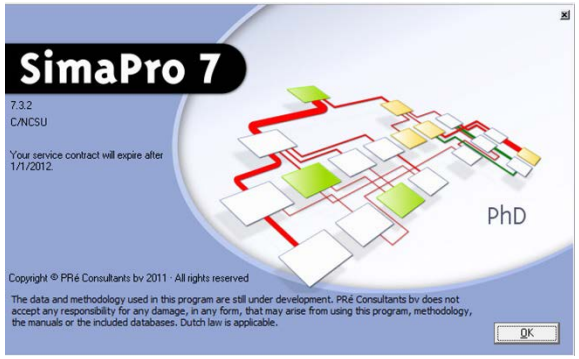
- A laptop is built with the following inputs:
  - 10 grams of copper
  - 20 grams of aluminum
  - 1 gram of lead
  - 0.5 grams of lithium
  - 0.5 grams of cobalt
  - 50 grams of polycarbonate
  - 10 grams of polyethylene
  - 2 grams of epoxy
  - 15 gram of rubber
- Using a 1% mass cut off criteria, which of these would be included in the LCA?

Scope: Data Collection Methods

Literature

Measurements

LCA Software

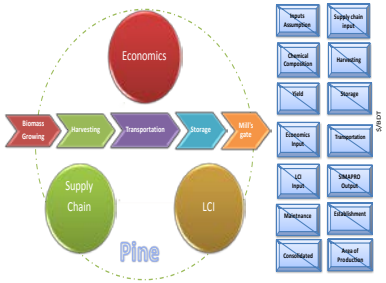


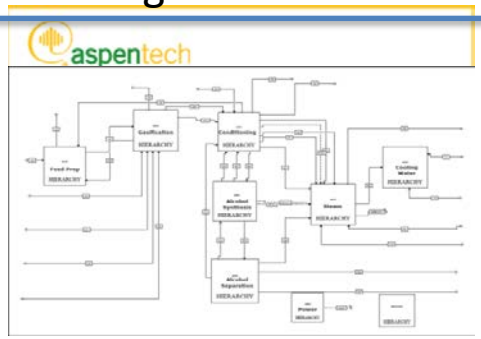
Databases

ecoinvent Centre

U.S. Life Cycle Inventory Database

Process Modelling





Allocation

- **Allocation:** partitioning the input and output flows of a process or a product system between the product system under study and one or more of the other product systems

(ISO 14044: 2006E)

Allocation Procedures

- Step 1: allocation should be avoided
  - by dividing the unit process into 2 or more subprocesses and tracking data for both separately
  - Expanding the system to include the additional functions of the related co-products
- Step 2: partition the inputs and outputs between products in a way that reflects underlying physical relationships
- Step 3: partition the inputs and outputs between products in a way that reflects other relationships between them, eg, economic value

Refs: Michael Hauschild, DTU

Avoidance of Allocation: Divide the process

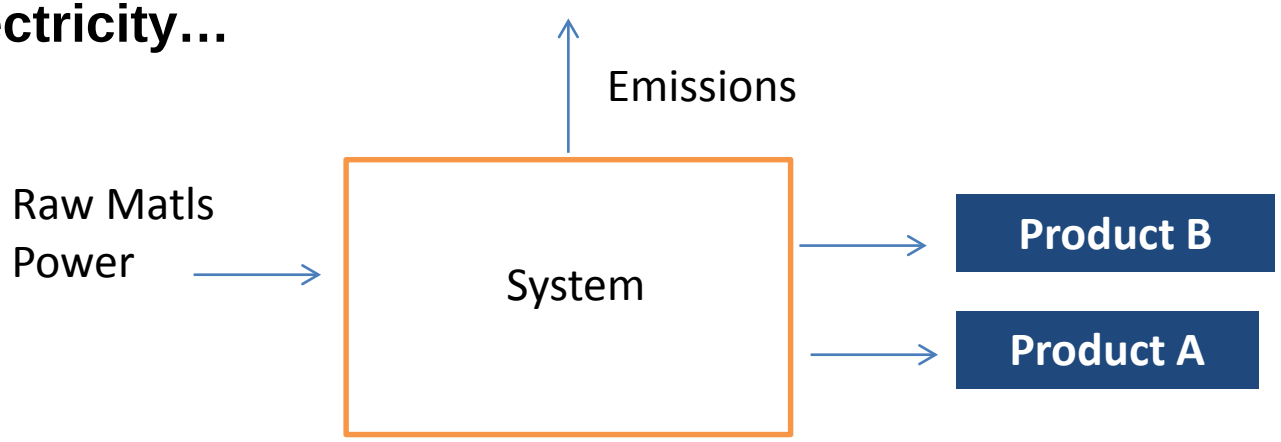
- **Example: A plastic injection molding device makes beverage containers or at other times makes toy parts.**

Avoidance of Allocation: System Expansion

- **Example: municipal waste is burnt, reducing the amount of waste landfilled but also producing electricity**

Allocation Issues: Co-products:

- **Co-products Allocation: a single process produces multiple products,**
  - **Burdens can be partitioned by mass flows, volume flows, piece flows, monetary values….**
  - **Must use process/product knowledge to determine partioning method**
  - **Example for paper production: paper, Tall Oil, turpentine, electricity…**



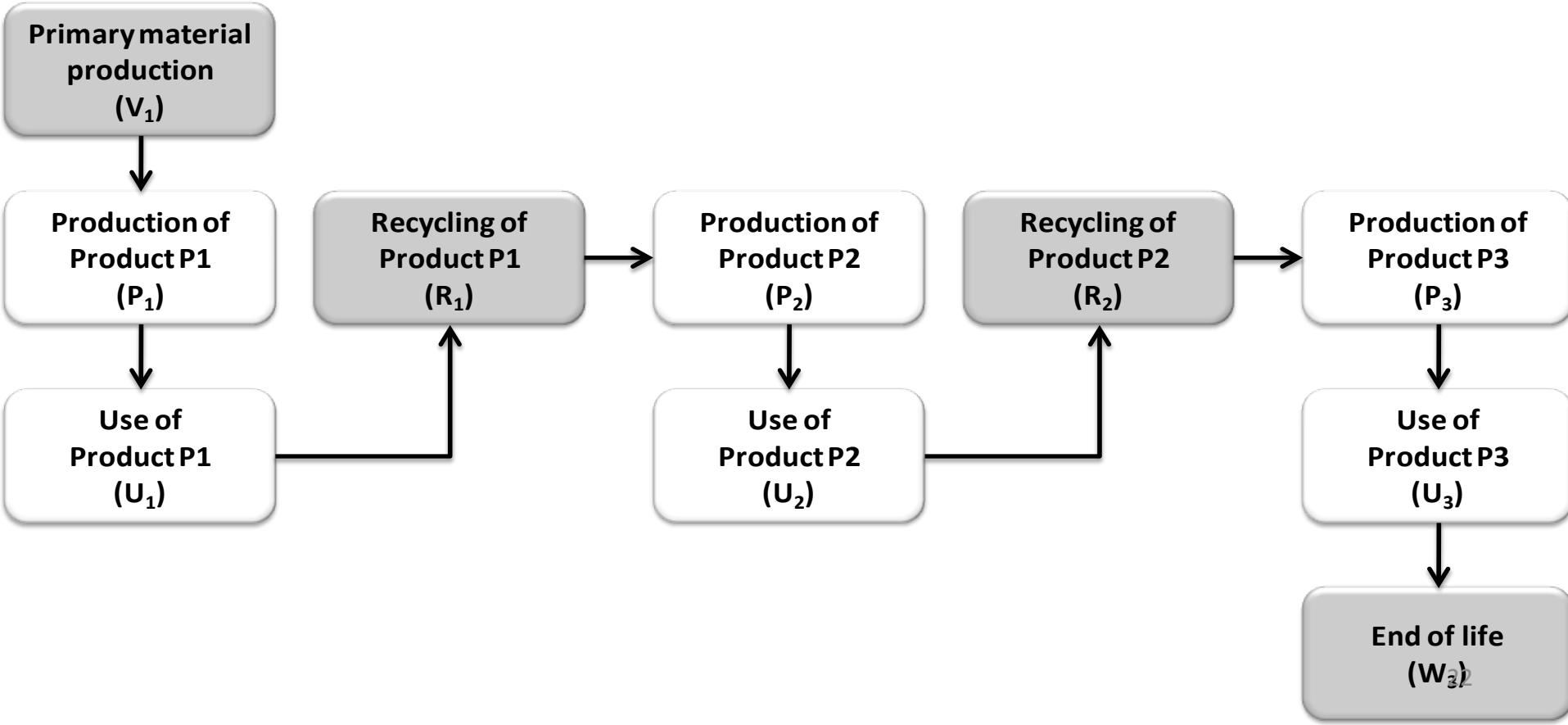
Allocation Issues: Co-products:

- **Example: Papermaking process co-products:**
- **Paper, 1000 t/day, $1000/t**
- **tall oil, 50 t/day, $2000/t**
- **Turpentine, 10 t/day, $5000/t**
- **Electricity, 1 MWhr/day, $100/MWhr**

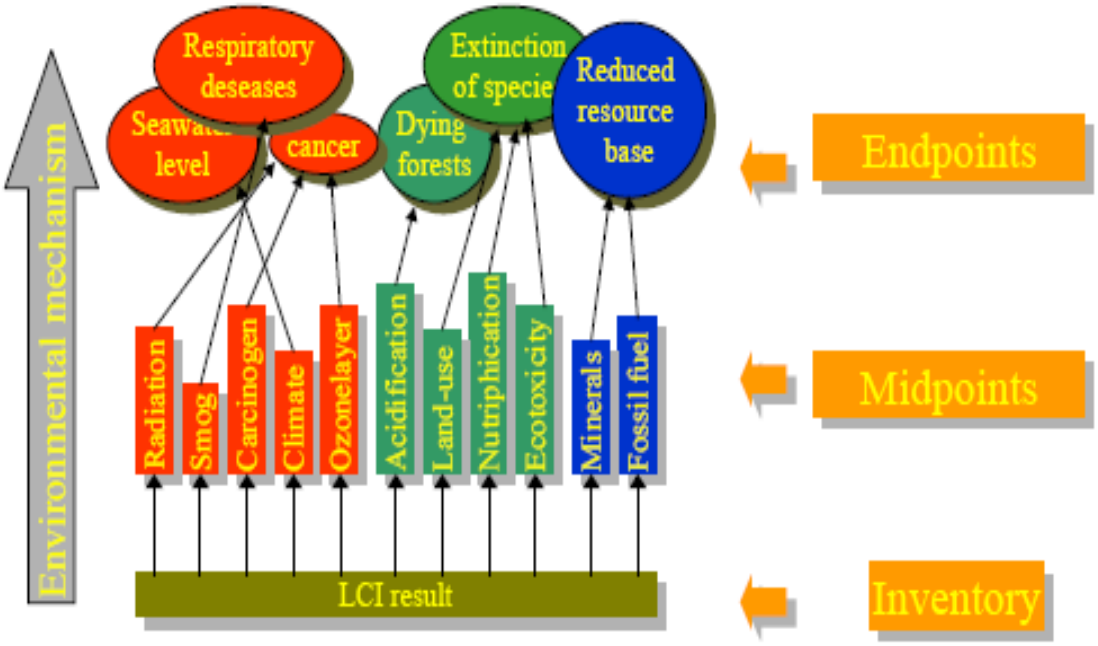
- **Mass and/or Economic allocation?**

Allocation Issues: Recycling

- **Recycling Allocation: a virgin product is recycled or re-used in a subsequent life**
  - **There exists operations that are required by the virgin and the recycled products (shared operations)**
  - **Example shared operations: virgin raw material production, final disposal**
  - **Many ways to allocate the burdens of the common operations**



Life Cycle Impact Assessment Methodology and Types of Impacts



Life Cycle Impact Assessment Methodology and Types of Impacts

Table 4.9 Orientation of Main LCIA Methodologies.

Distance-to-Target	**To Midpoint**	**To Damage or AoP**
Critical Volumina	CML (9+)	EPS (5)
Ecoscarcity (15)	EDIP (9)	Eco-indicator 99 (3)
	TRACI (12)	
	ILCD Handbook[a] (15)	ILCD Handbook[a] (3)
	Midpoint-Damage	
	IMPACT 2002+ (14–4)	
	LIME (11–4)	
	ReCiPe[b] (18–3)	
	IMPACT World+[c] (30–3)	

Numbers in parentheses (n) indicate the number of indicator categories.

Life Cycle Impact Assessment Methodology and Types of Impacts

• TRACI, The Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts

- •Global Warming
- •Acidification
- •Human health: Carcinogenics
- •Human Health: Non carcinogenics
- •Respiratory Effects
- •Eutrophication
- •Ozone Depletion
- •Ecotoxicity
- •Smog
- •Fossil Fuel Use (limited)

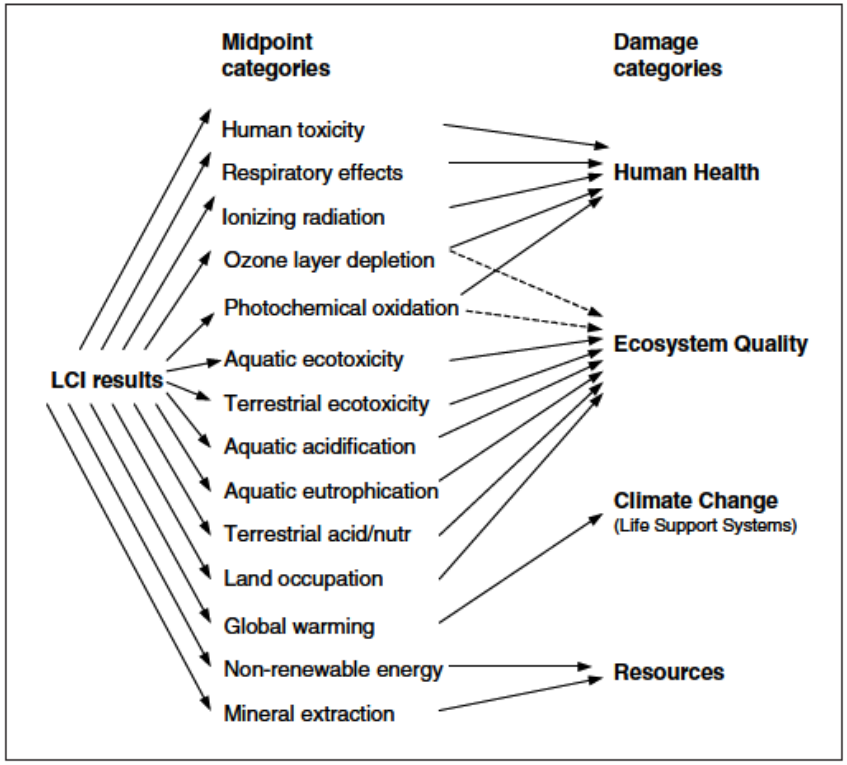


Fig. 1: Overall scheme of the IMPACT 2002+ framework, linking LCI results via the midpoint categories to damage categories, based on Jolliet et al. (2003a)

Data Quality Requirements

- Age of data
- Geographical coverage of data
- Technology data: specific or mix
- Precision: measure of variability
- Completeness: % of flow that is measured
- Representativeness
- Consistency
- Reproducibility
- Sources
- Uncertainty: for instance models

Scope definition: Milk Example

- Design a goal and scope for a milk manufacturer that wants to learn more about the environmental impacts in New England for the production and sales functions of whole milk up to the point of purchase.

Milk: Goal and Scope

- Goal
- The product system studied (what processes will be included?)
- The functions of the product(s) studied
- The functional unit

Milk: Goal and Scope

– The system boundary

Milk: Goal and Scope

– Allocation procedures

Milk: Goal and Scope

- LCIA methodology and types of impacts
- Data requirements
- Assumptions
- Limitations

Summary

- Goal
- Comparative assertions
- Scope
- Functional unit
- Reference flow(s)
- System boundary
- Cradle to grave
- Cradle to gate
- Gate to gate
- Cut off criteria
- Allocation
- Coproducts
- Recycling
- System expansion