LCA workshop

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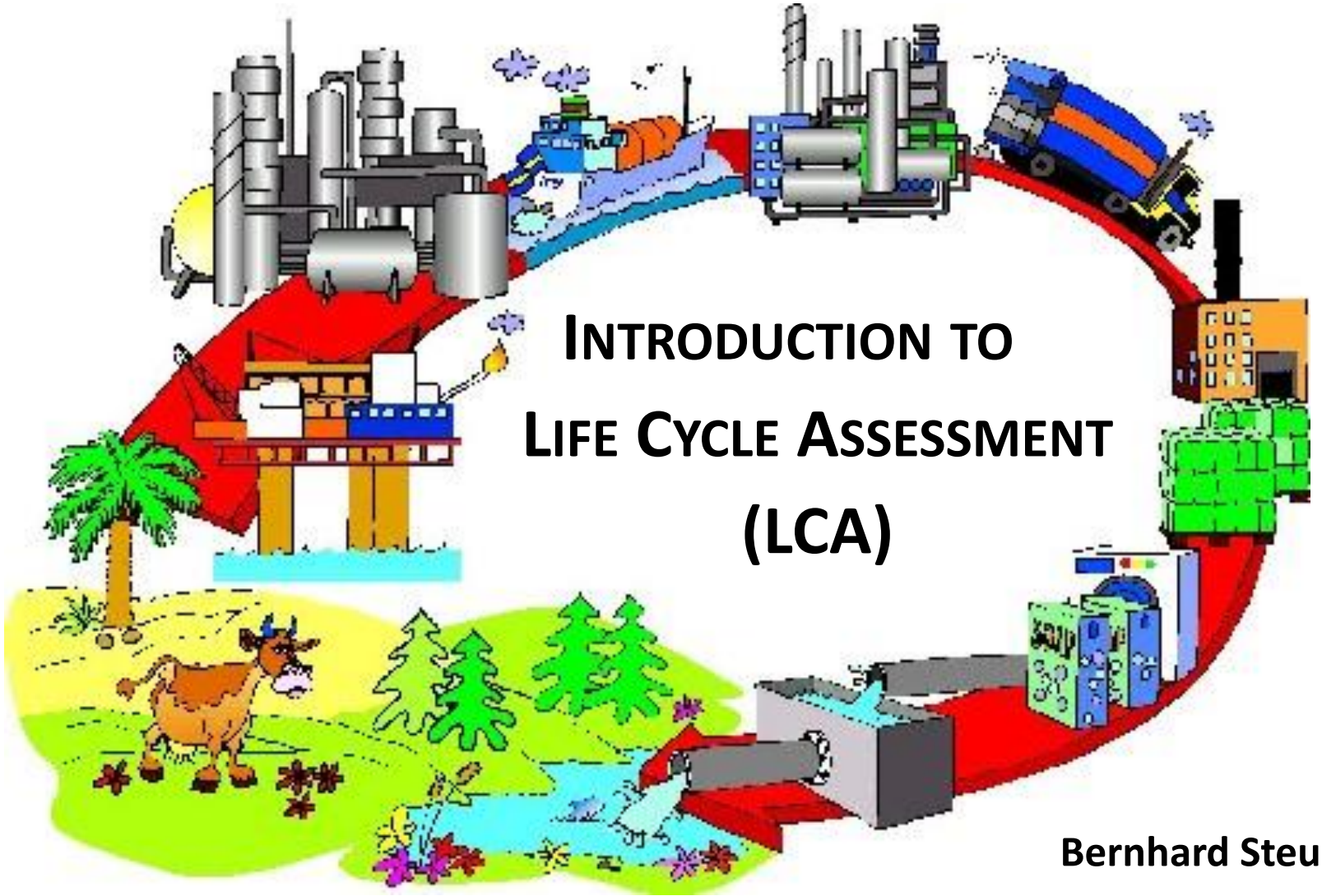
Chris Mutel, Technology Assessment Group, PSI)

Objectives:

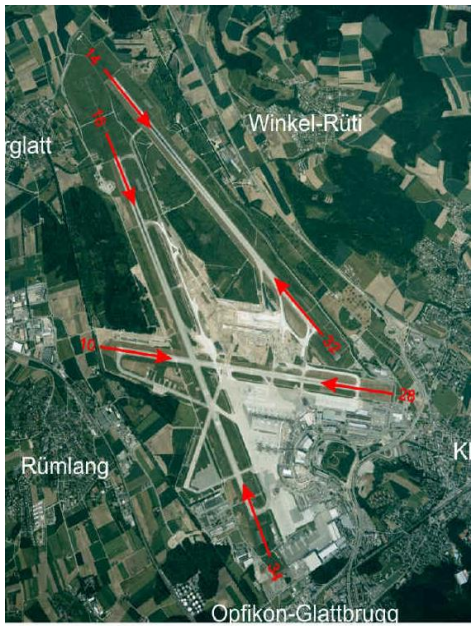
- Basic understanding of LCA
- Position yourself on a relevance/complexity chart
  - Specific and appropriate tools and data sources



Introduction to Life Cycle Assessment (LCA)

Bernhard Steubing

What is the environmental impact of…?

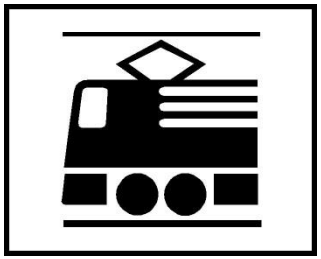


1‘000 pkm Transport

Source:
Rolf Frischknecht

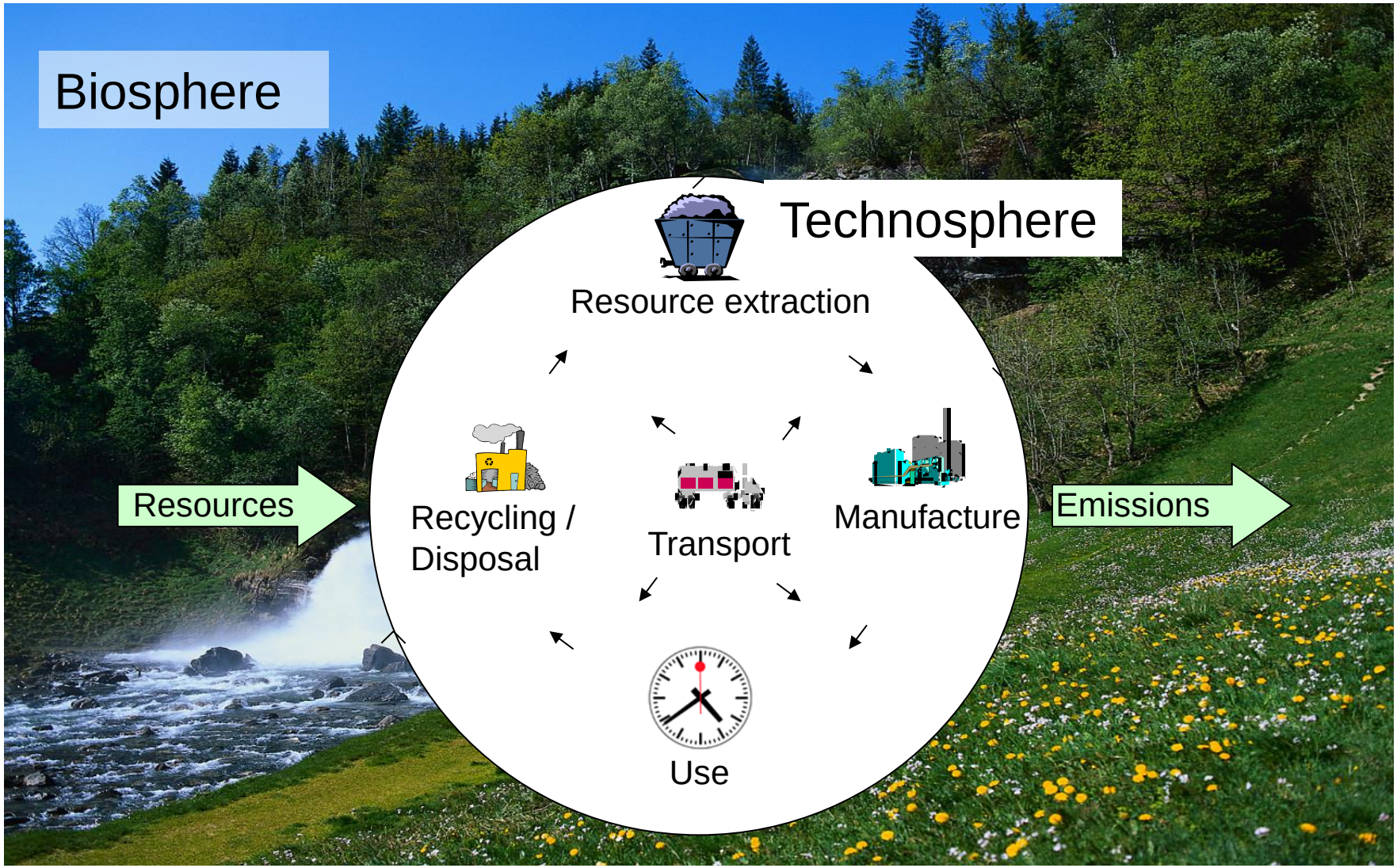
Often comparisons:
what is better for the environment?

Services



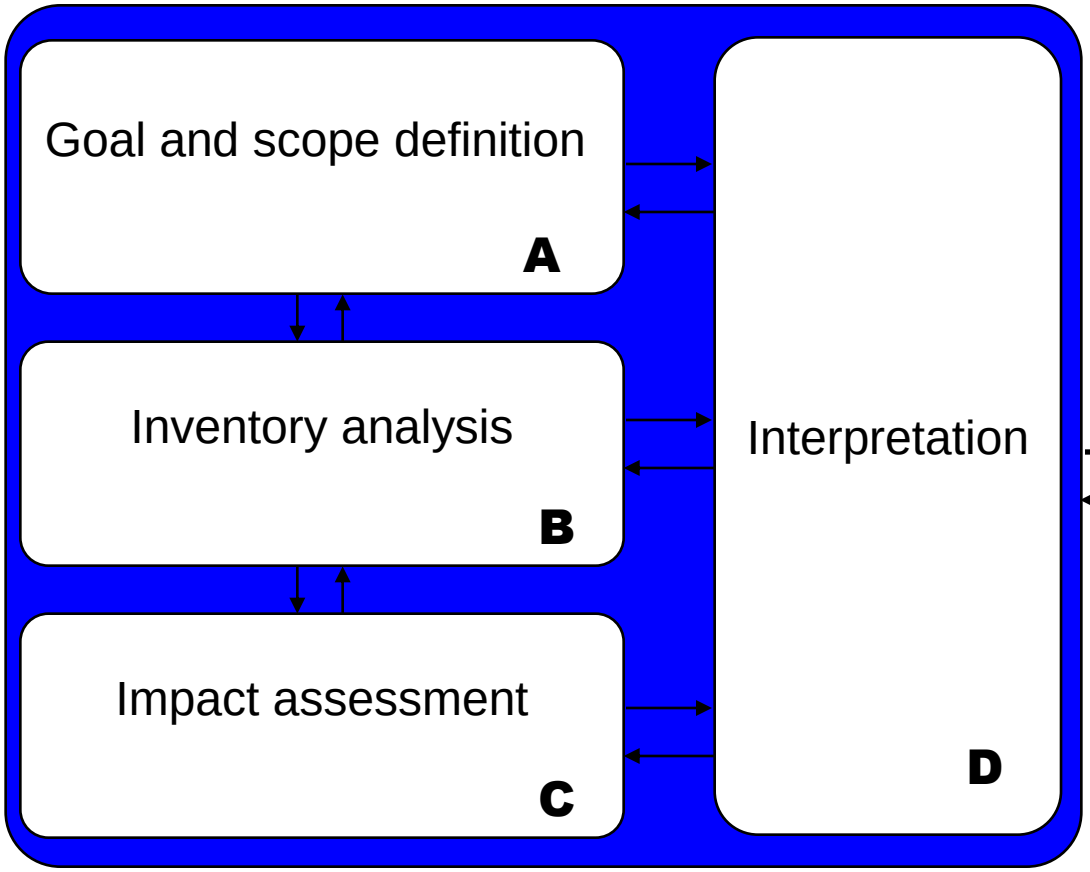
Products

Life cycle assessment (LCA) is the compilation and evaluation of the inputs and outputs and the potential environmental impacts of a product system throughout its life cycle



LCA: Systematic procedure

Proceeding to establish an LCA: ISO 14’040 and 14’044



Elements according to EN ISO 14040, 1997

Direct application:
- Development and improv-ment of products
- strategic planning
- political decision making
- marketing
- others

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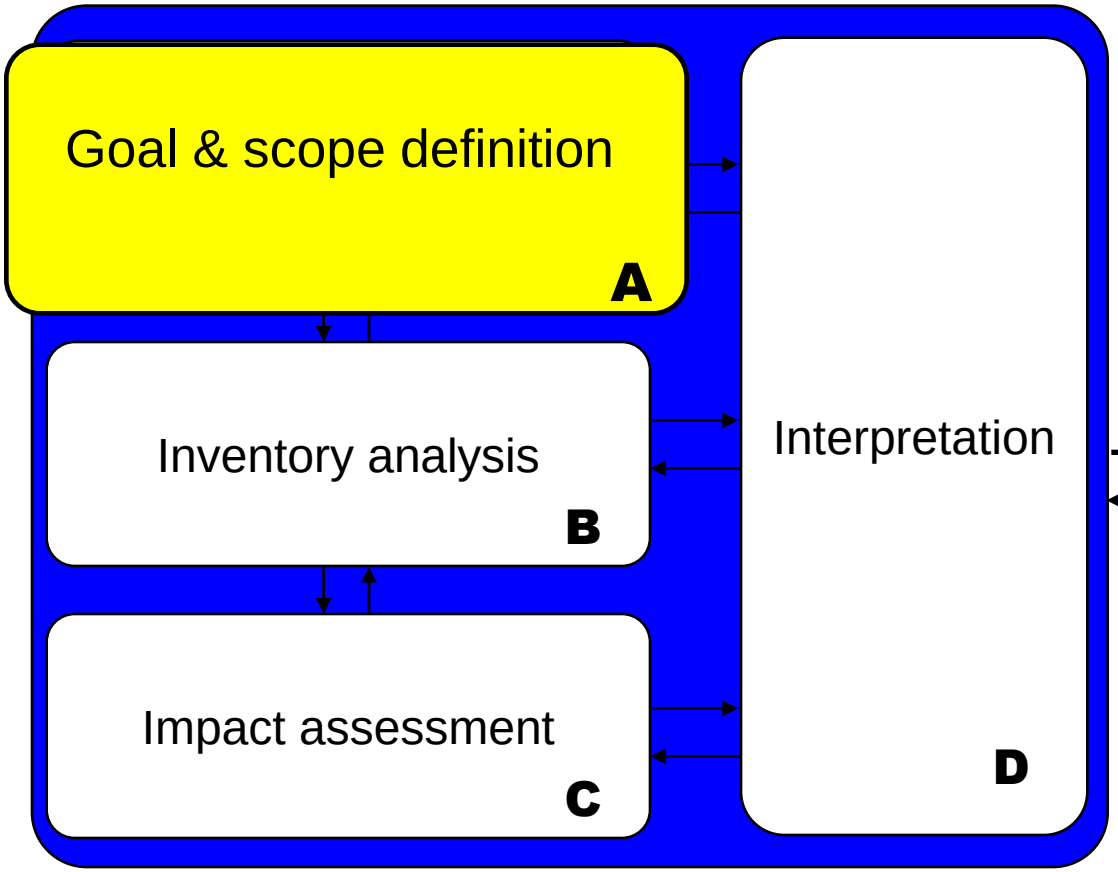

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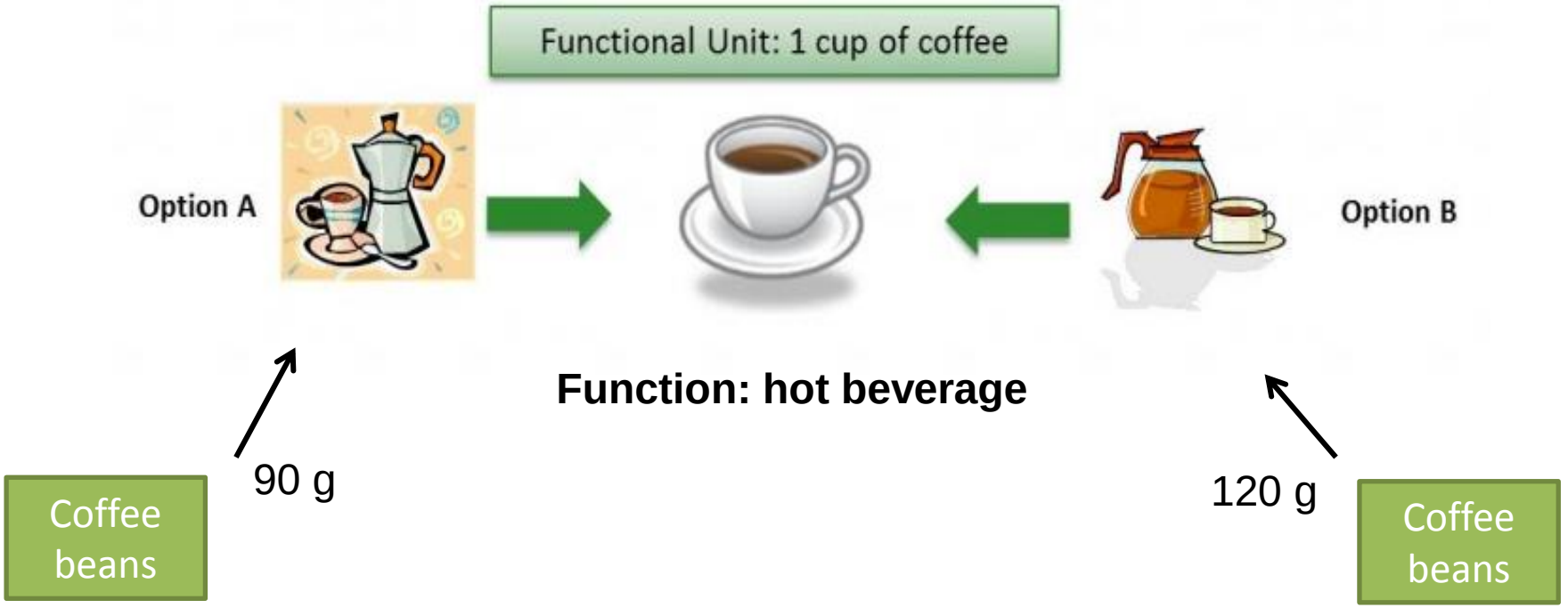
Goal and scope: typical questions

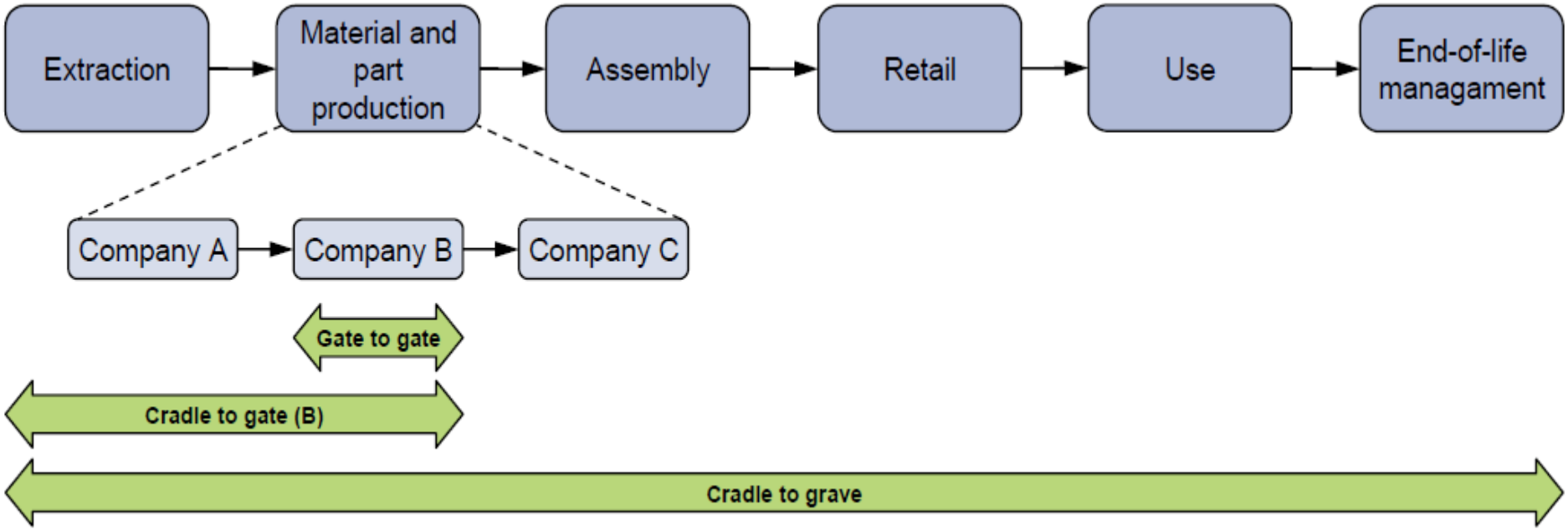
- Aim of the study? (e.g. product comparison?)
- Functions of the system?
- System boundaries (geographical, temporal, technological, etc.)?
- Allocation approaches?
- Assumptions?
- Environmental indicators?
- Target audience? (internal vs. external)

Function, functional unit and reference flow

- **Function**: what the system is supposed to deliver
- **Functional unit**: unit and amount that the function is measured by



System boundaries: “Cradle to gate”, “cradle to grave” and “gate to gate”



LCA Systematic procedure

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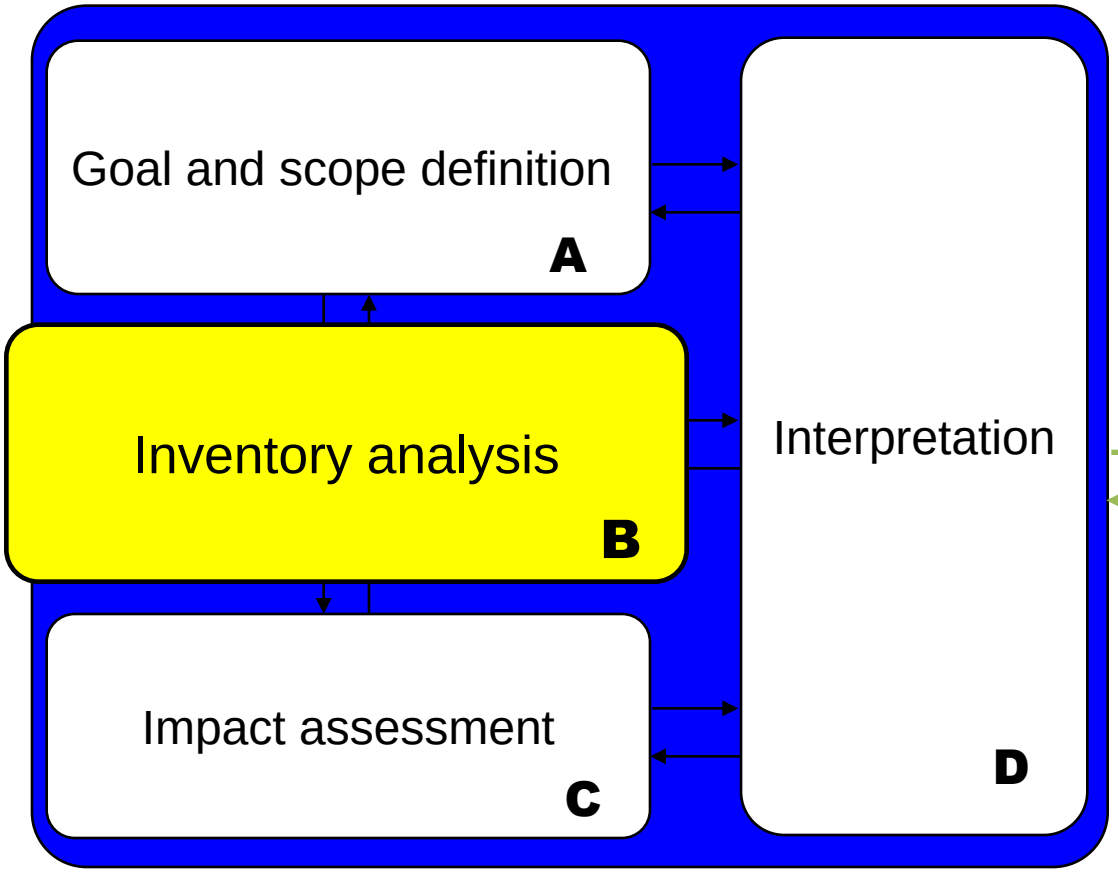

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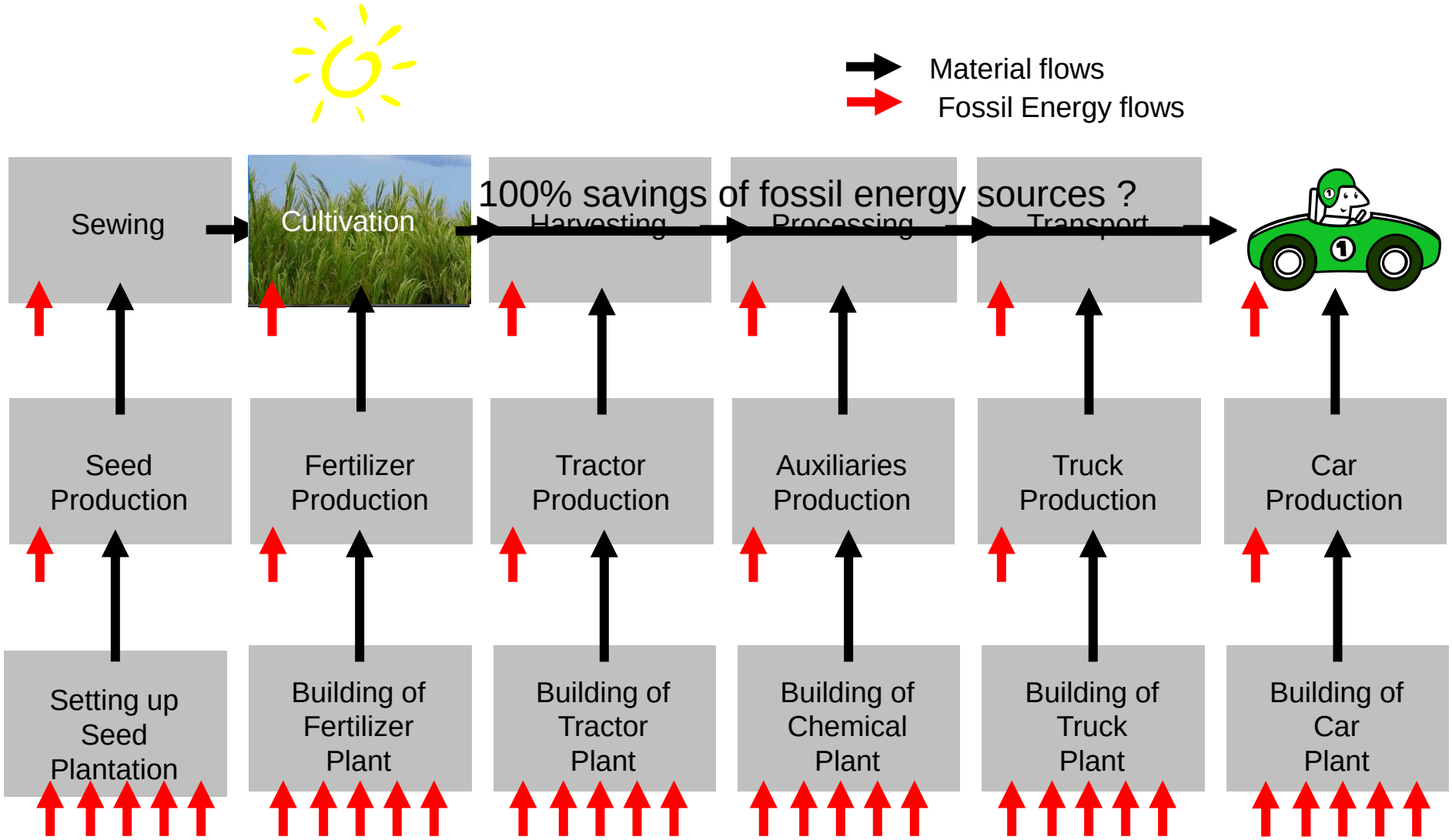
Up- and downstream processes
Example “flying”

1‘000 pkm Transport

Source:
Rolf Frischknecht

Example: Fossil Energy Demand of Biofuels

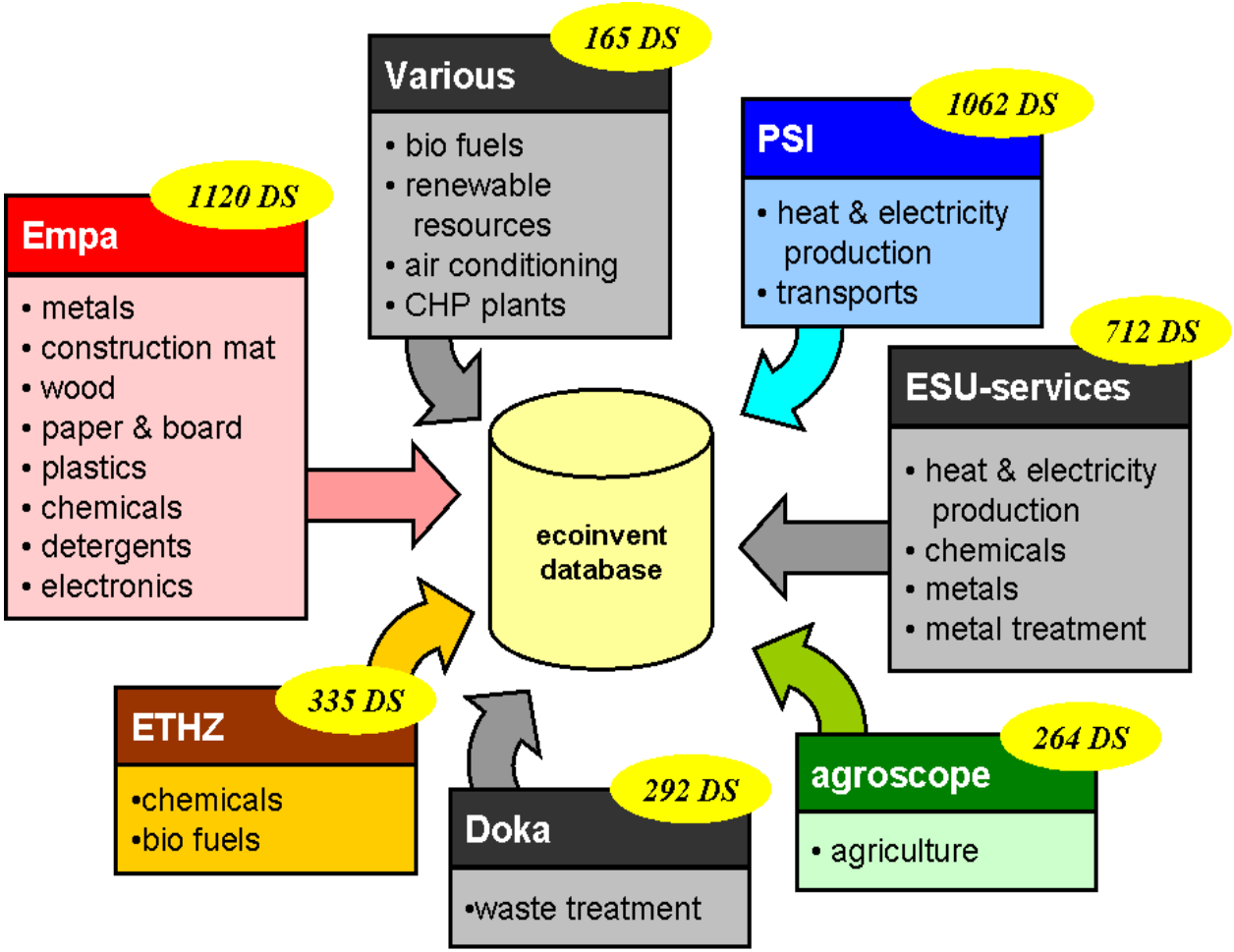


Source: Empa

Background data: ecoinvent database

v2.2: ~4000 inventories

V3: ~11000 inventories



www.ecoinvent.org

Multi-Output Processes

Production of several products within the same process

Example: Chlor-Alkali-Electrolysis

$$2H_2O + 2NaCl \rightarrow 2NaOH + Cl_2 + H_2$$

„Fair“ distribution of emissions and resource inputs to different products?

Allocation approaches

Distribution of emissions and resource inputs to different products

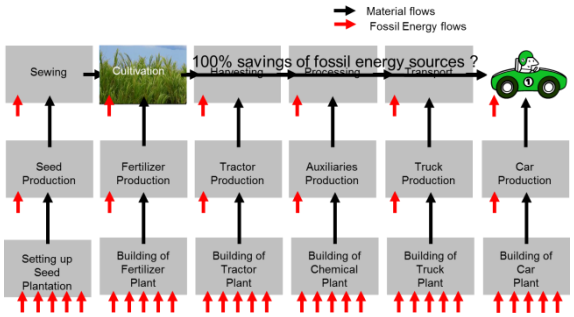
Procedure according to ISO 14044::

1. **A) Subdivisioning of processes**
   B) System expansion: Expansion of a system with additional functions in a way that all compared systems fulfill the same functions.
2. Allocation according to **physical or chemical relationships**
3. Allocation on the basis of other relationships: e.g. **economic value**

ISO 14044, 2006

Result of the inventory analysis

Sum of all biosphere flows (environmental interventions) throughout the product system



Name	Category	Unit	methanol, at plant	methanol, at regional storage
Oil, crude, in ground	resource	kg	0.0057	0.0191
Gas, natural, in ground	resource	Nm3	0.93	0.932
Carbon dioxide, fossil	air	kg	0.517	0.524
Nitrogen oxides	air	kg	0.0008	0.0011
Methanol	air	kg	0.00053	0.00103
…	…	…	…	…

Direct interpretation

Impact assessment

Source: Stefanie Hellweg

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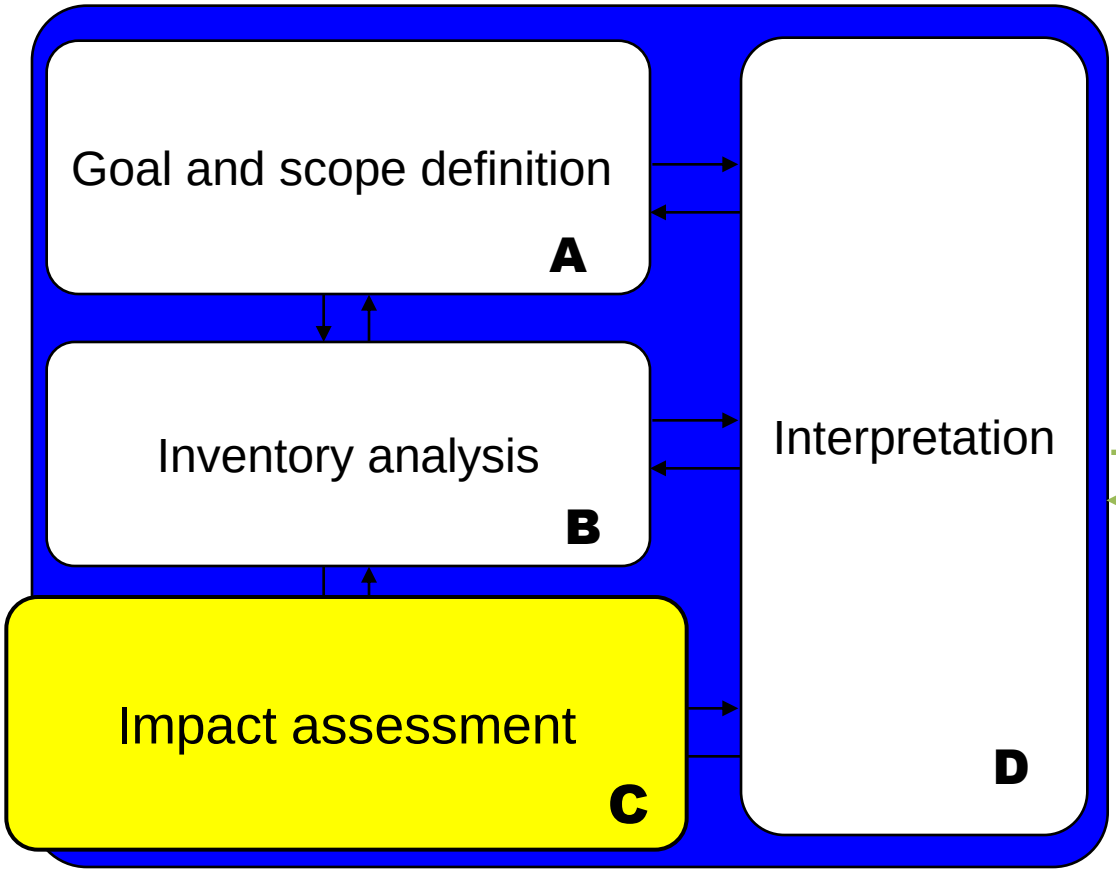

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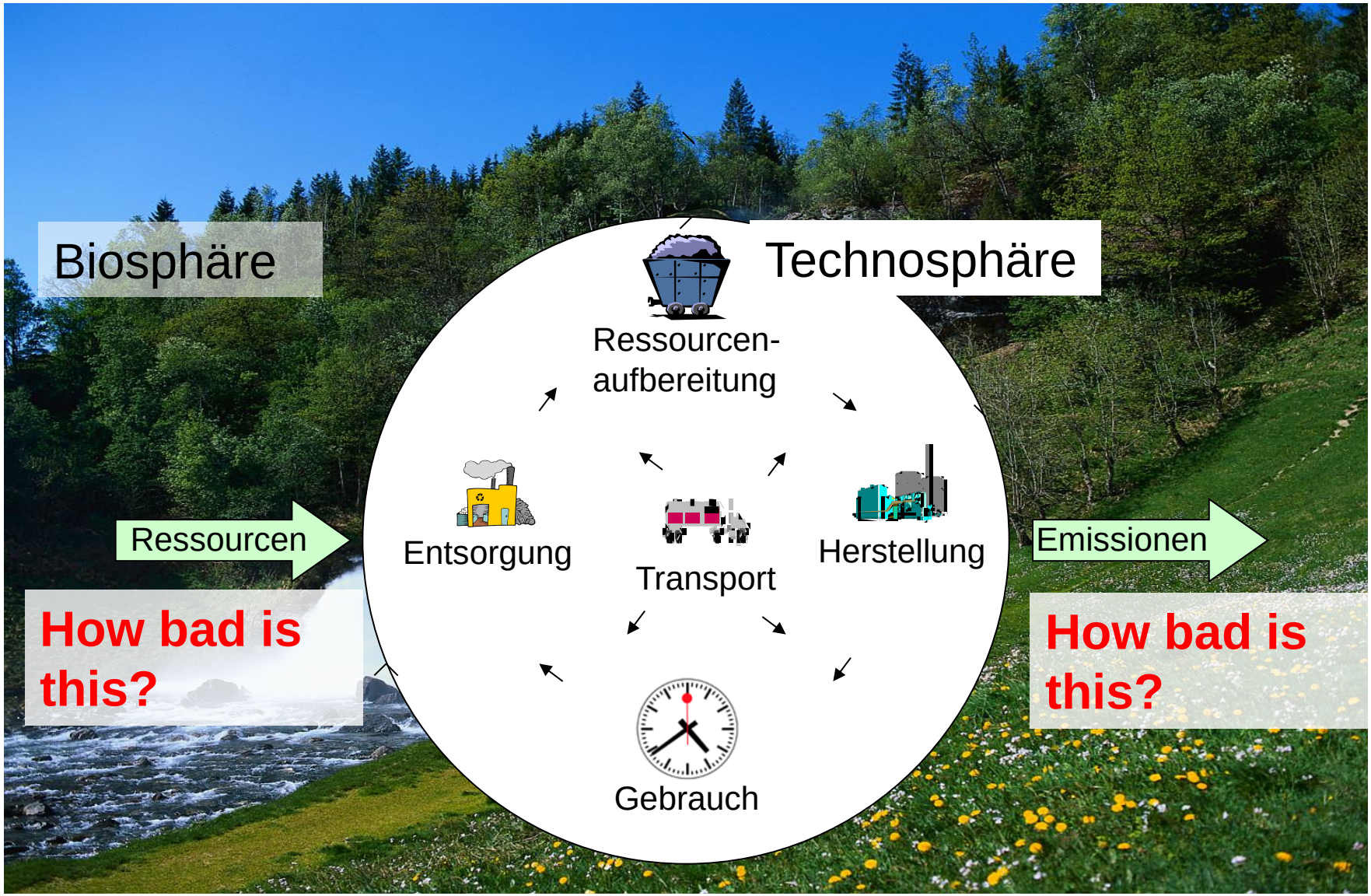

Biosphäre
Technosphäre
Ressourcen-
aufbereitung
Herstellung
Transport
Gebrauch
Entsorgung
Ressourcen
Emissionen
How bad is this?
How bad is this?

Range of environmental problems

There are interconnections between environmental issues

Human toxicity

Ecotoxicity

Air pollution

Soil degradation

Climate change

Ressource depletion

Biodiversity loss

Water contamination

Impact assessment

Inventory

Emission	unit	compart-ment	amount per FU
CO_2	kg	air	0.5
CH_4	kg	air	1.0
N_2O	kg	air	0.01
NO_x	kg	air	0.5
PO_4	kg	water	0.5
Cd^{2+}	kg	water	0.0001
Fe	kg	soil	0.5
Cu	kg	resource	3
...			

Impact assessment

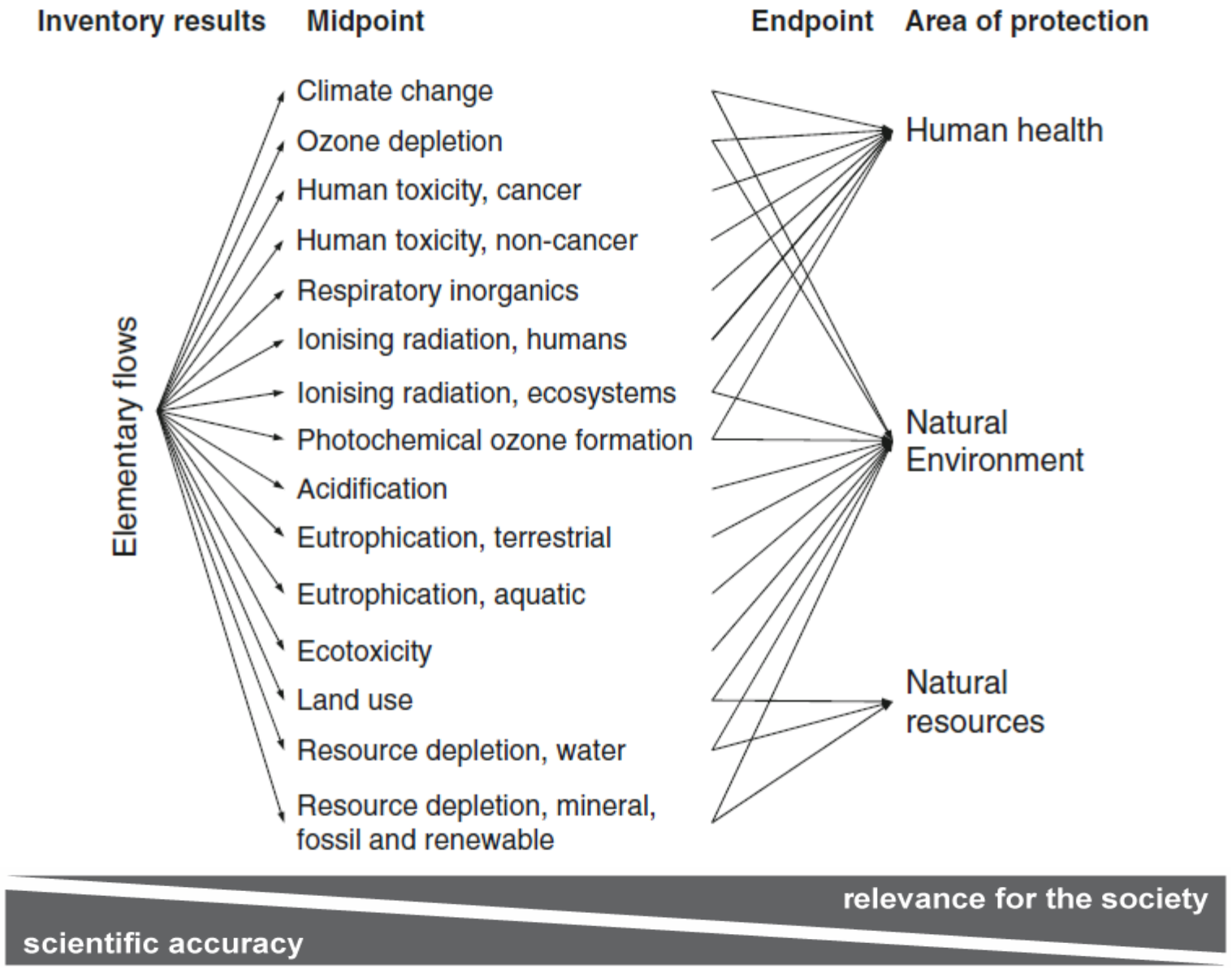
Global Warming

Emission	*CF*	***CO_2–eq.***
CO_2	1	0.5
CH_4	23	23.0
N_2O	296	2.96
Summe		26.46

Eutrophication		**PO4-eq.**
NO_x	0.1	0.05
PO_4	1	0.5
Sum		0.55

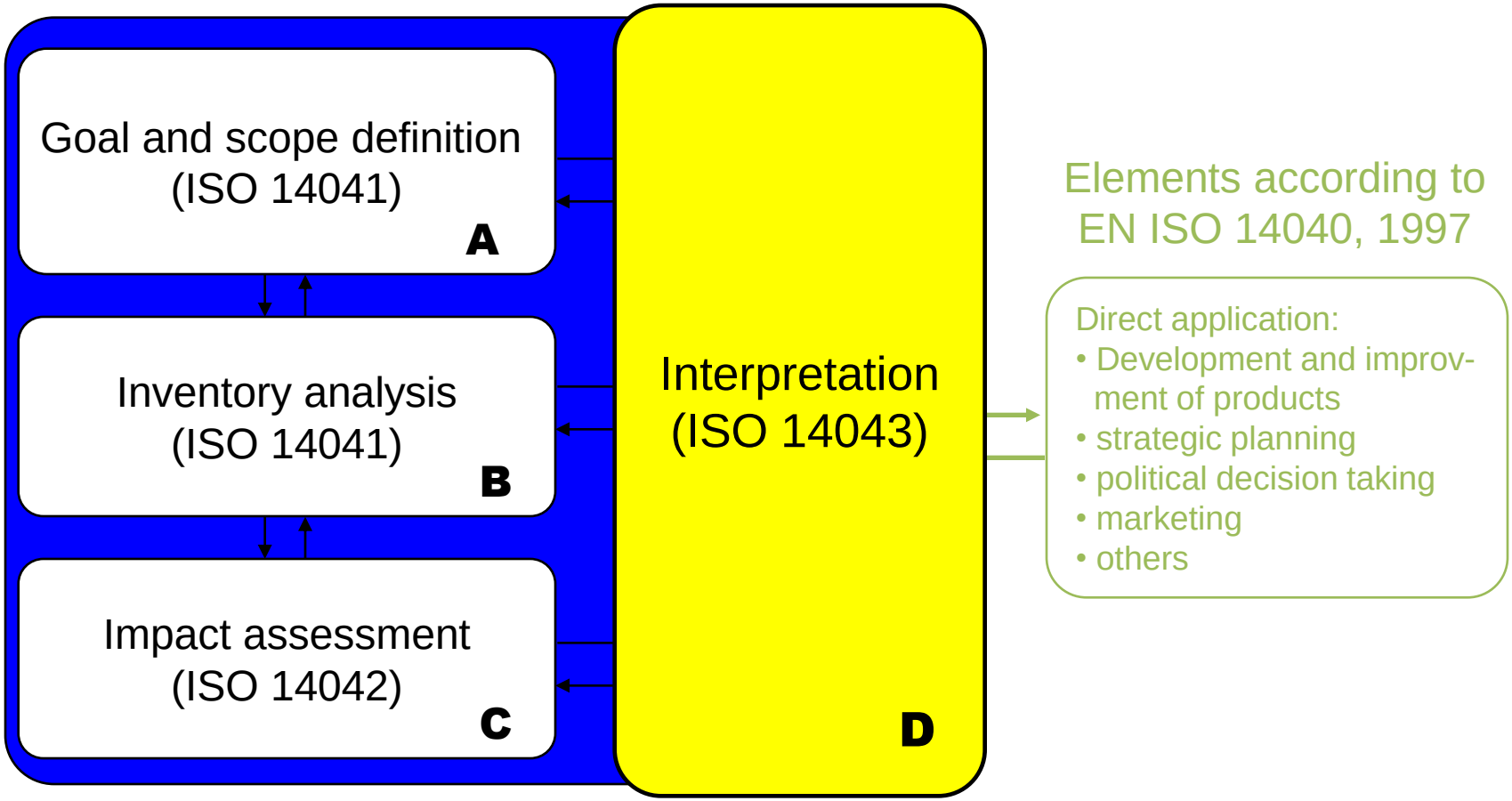
Human toxicity		***1,4 Dichlor-benzol***
NO_x	1.4	0.07
Cd^{2+}	23	0.0023
Sum		0.0723

Source: Stefanie Hellweg

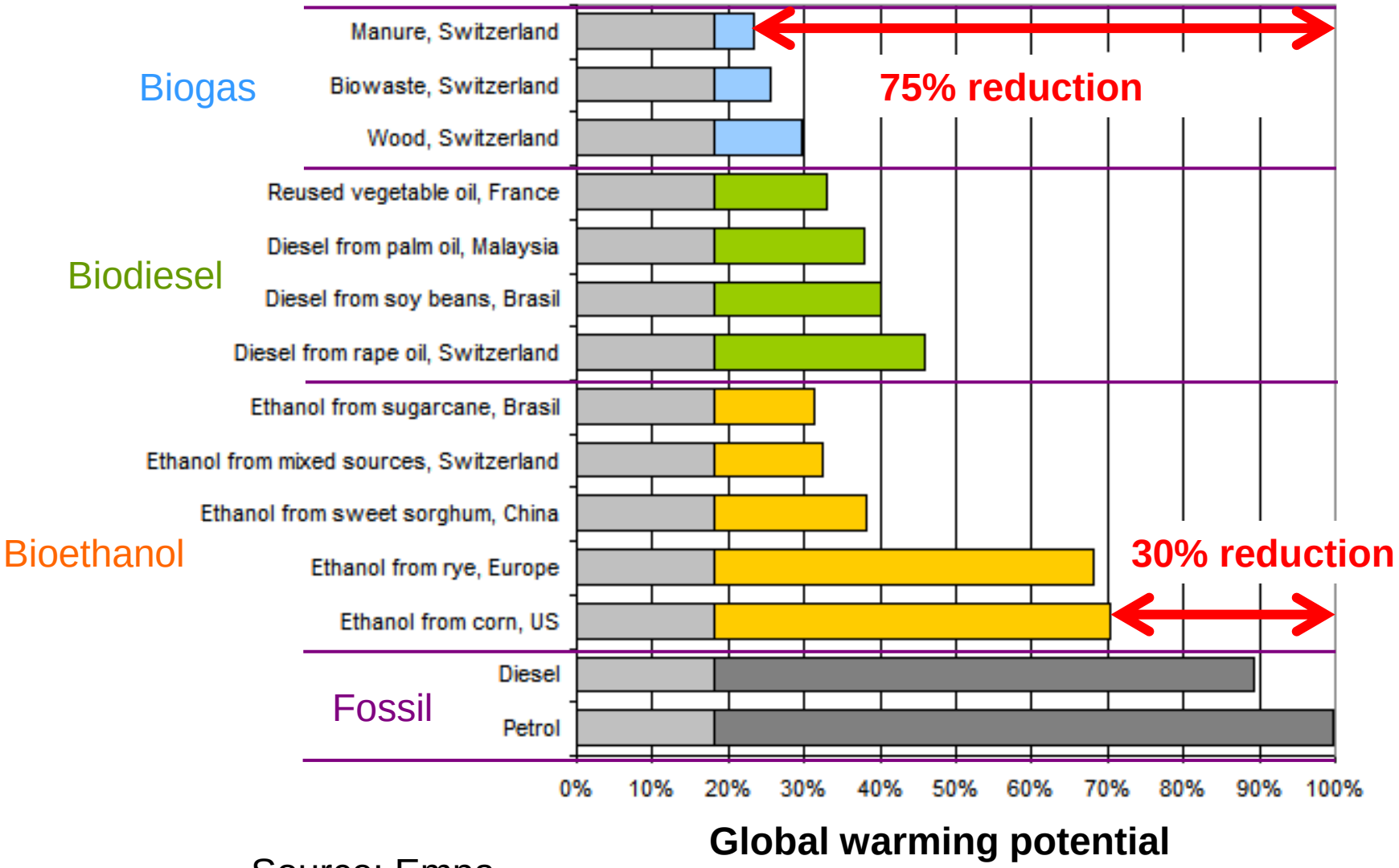

Inventory results
Midpoint
Endpoint
Area of protection
Elementary flows
Climate change
Ozone depletion
Human toxicity, cancer
Human toxicity, non-cancer
Respiratory inorganics
Ionising radiation, humans
Ionising radiation, ecosystems
Photochemical ozone formation
Acidification
Eutrophication, terrestrial
Eutrophication, aquatic
Ecotoxicity
Land use
Resource depletion, water
Resource depletion, mineral, fossil and renewable
Human health
Natural Environment
Natural resources
relevance for the society
scientific accuracy

Systematic procedure

Proceeding to establish an LCA according to ISO 14’040

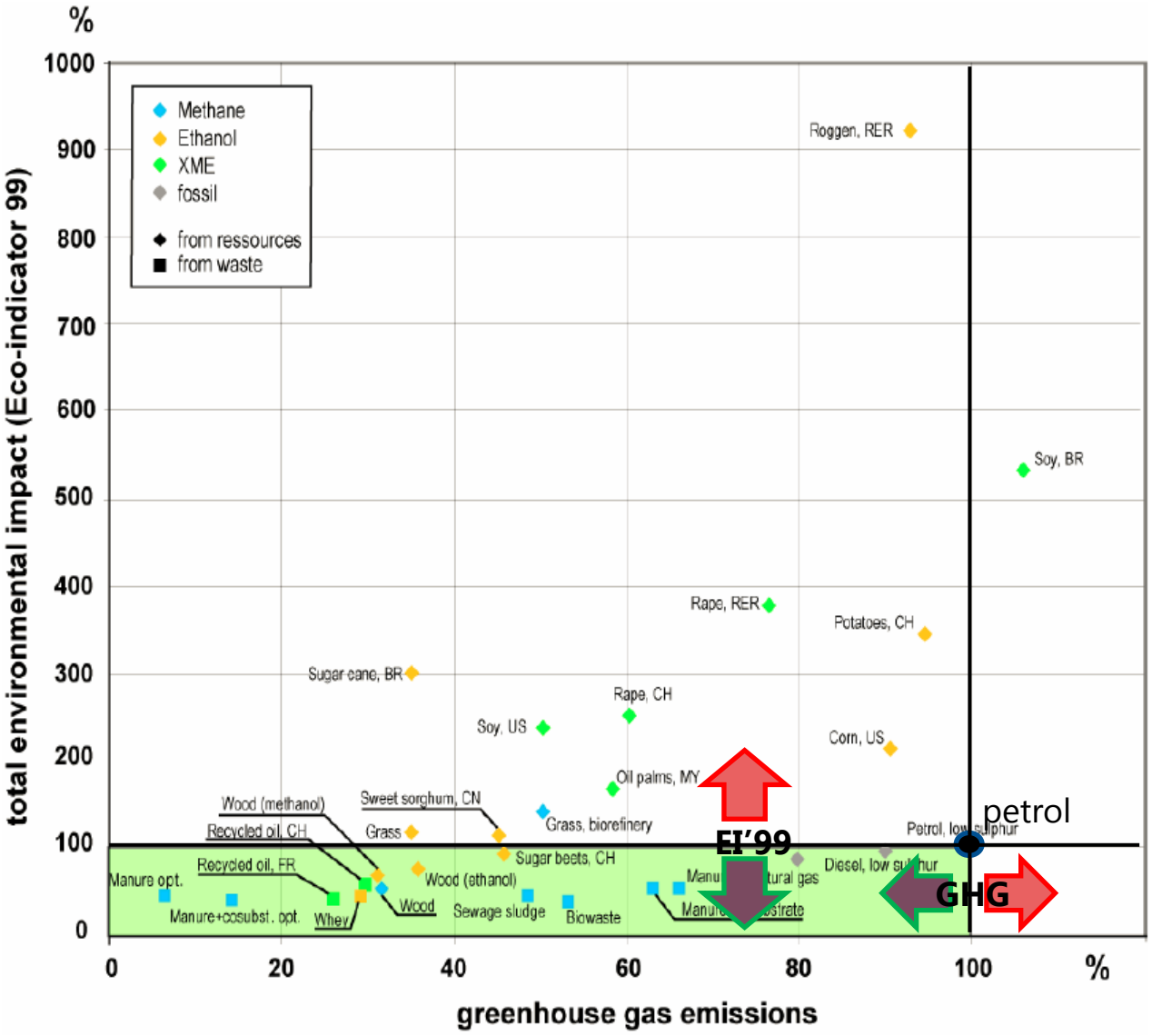


Example: Fossil energy consumption of biofuels:



Source: Empa

Trade offs between environmental concerns



Most biofuels show GHG benefits

But: many show higher impacts in other categories

➔ often **trade-offs**

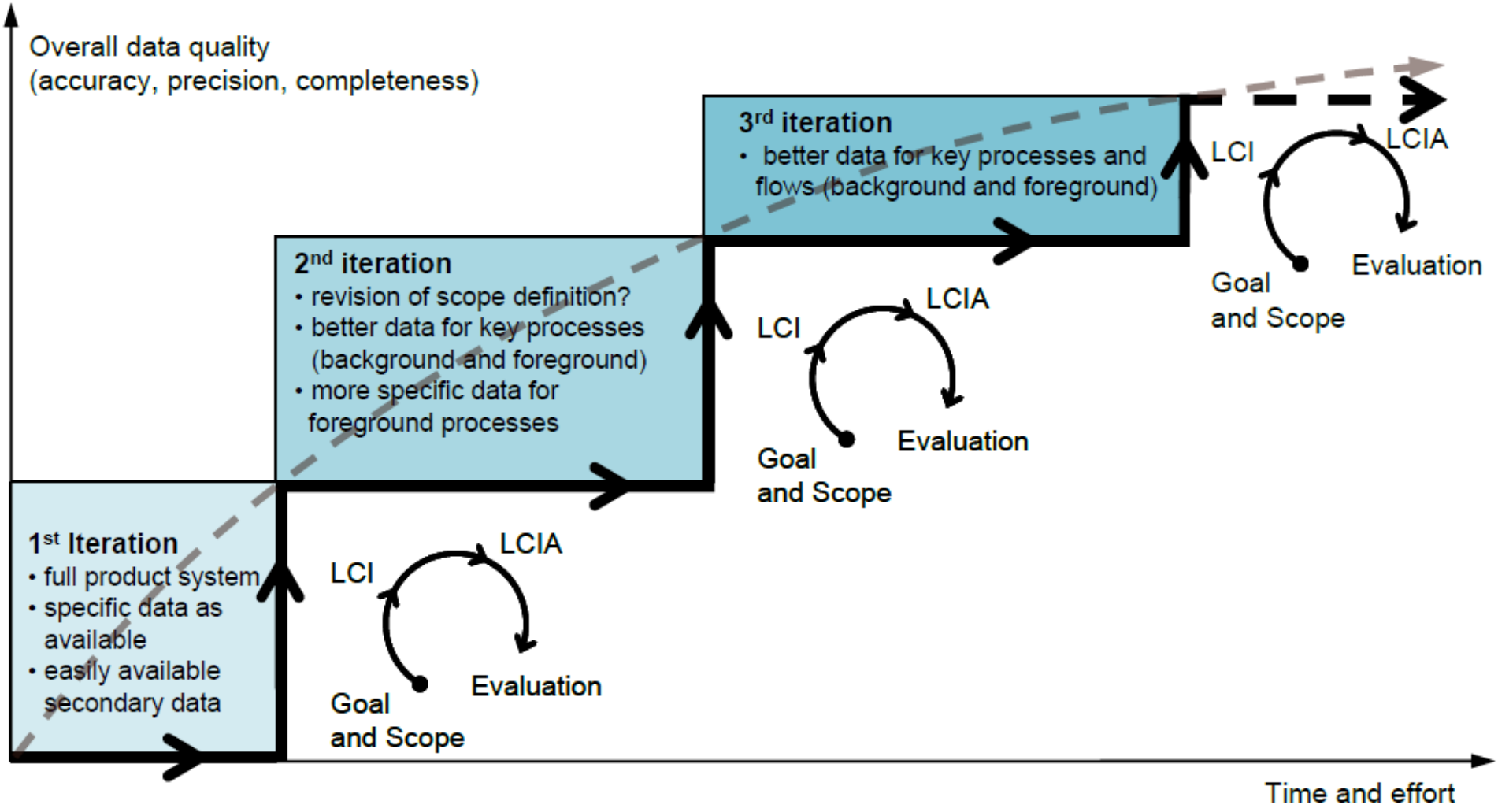
Source: Zah et al. 2007

Main questions

What are…

- the results?
- the uncertainties of the results?
- the results most sensitive to?
- the limitations of the study (e.g. what was not considered?)?
- the conclusions and recommendations?

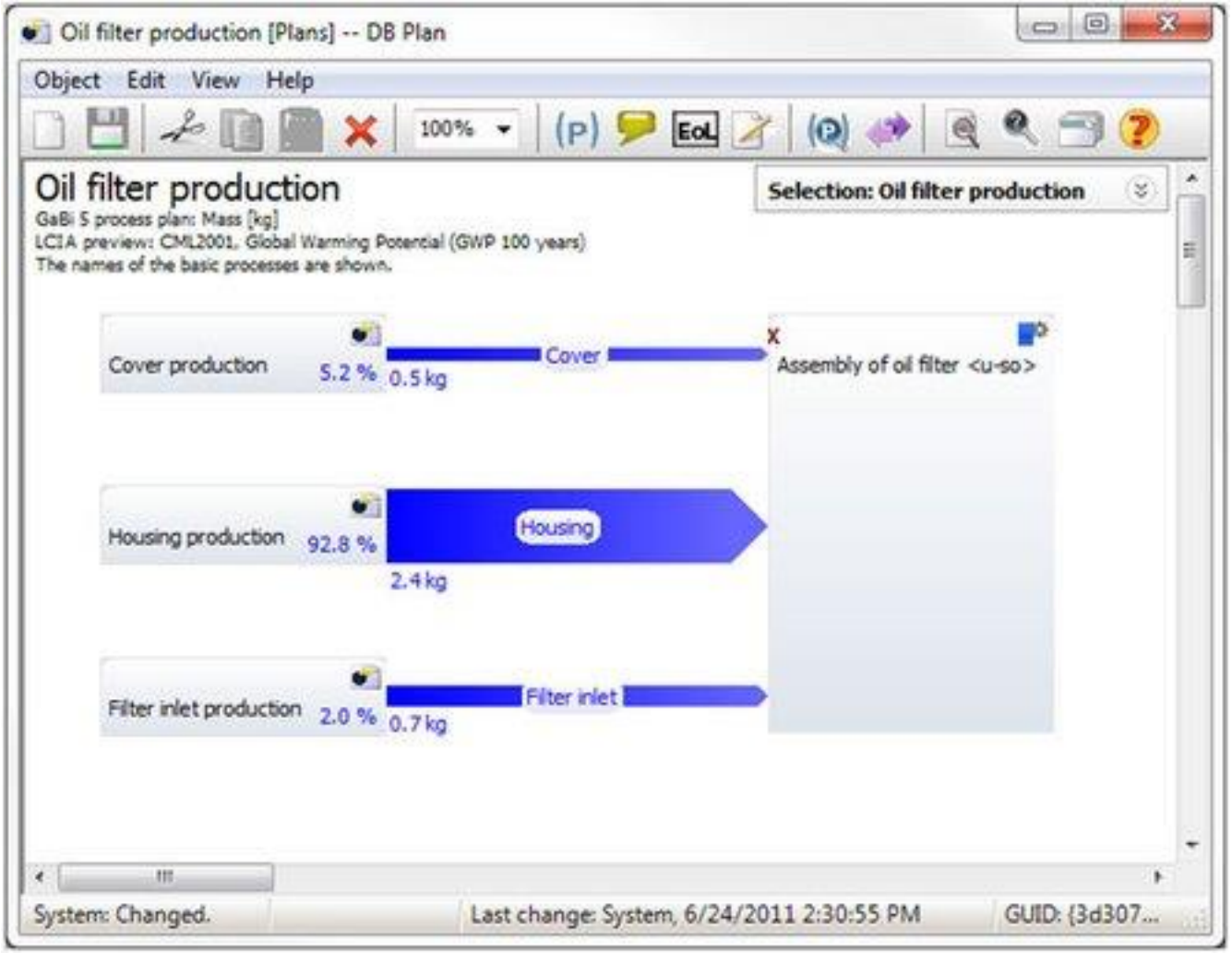
LCA can be an iterative process



Software

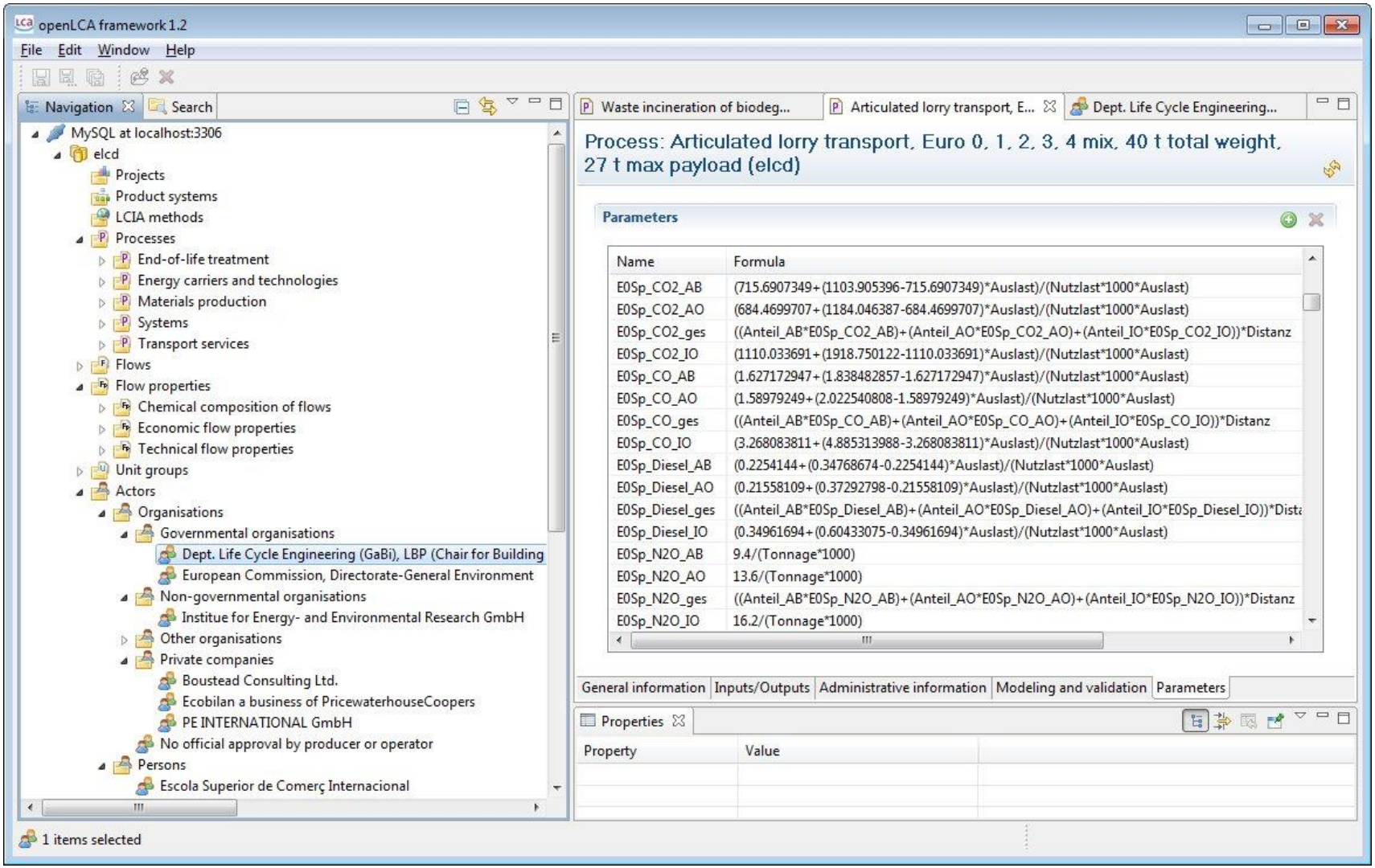
Simapro: http://www.pre-sustainability.com/

Software



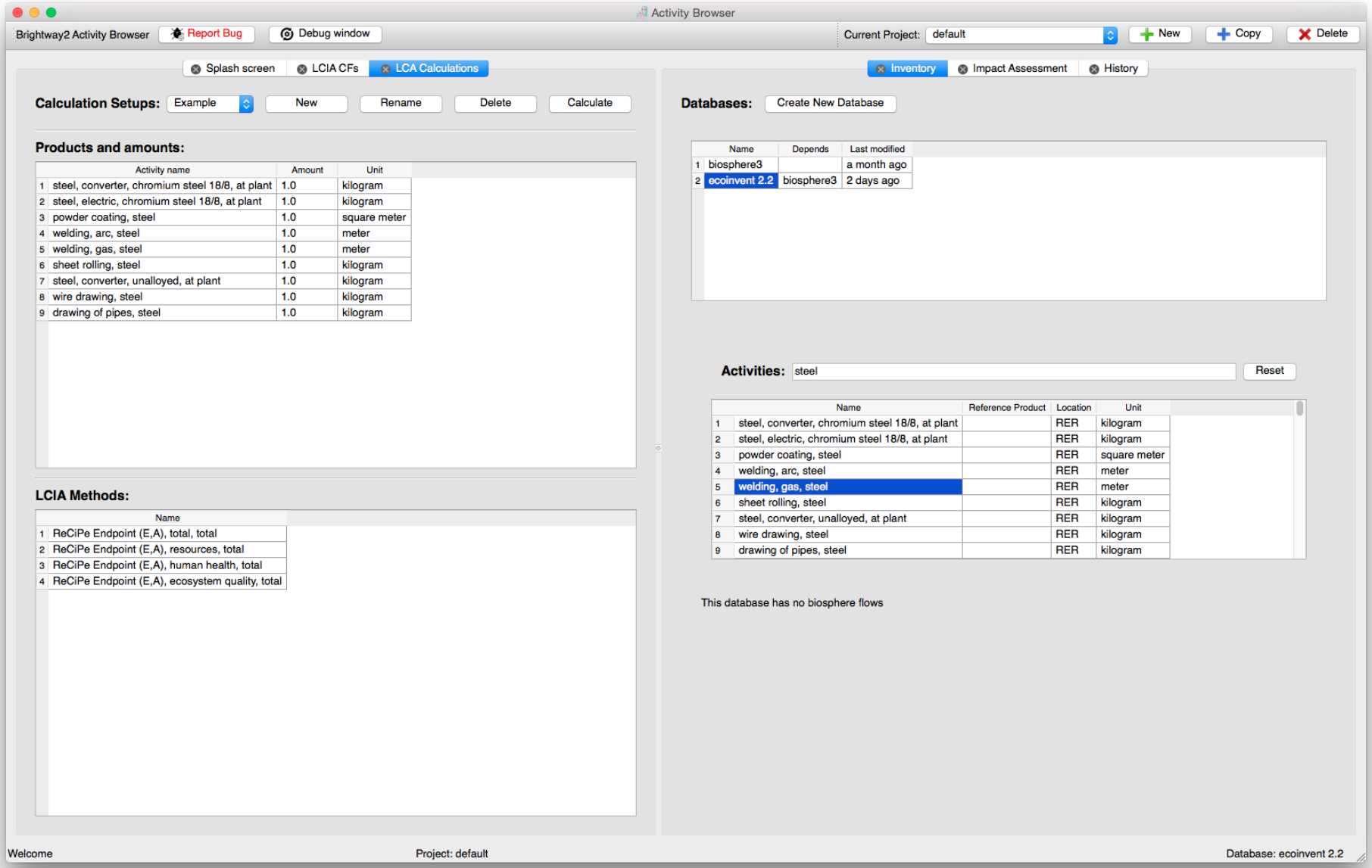
GaBi: http://www.thinkstep.com/

Software



OpenLCA: http://www.openlca.org/

Software



Brightway2 Activity Browser: http://brightwaylca.org/

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