

Lecture 4

Inventory analysis

- Foreground/background
- Average/marginal
- Allocation

Inventory analysis

- Identify process in product system & draw detailed flow chart
- Collect data
- Build model

Iterative process!



Foreground/background

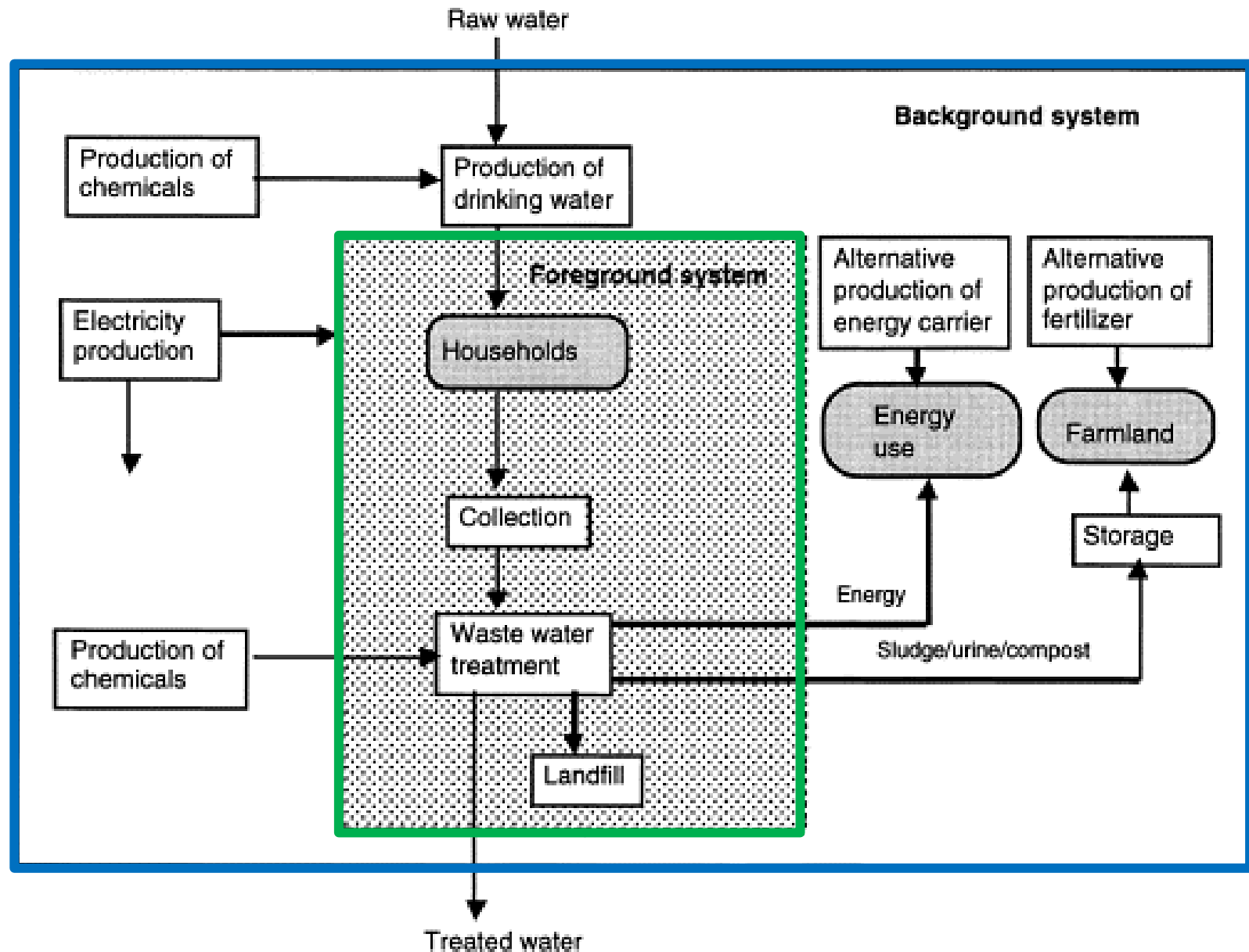
- Foreground
 - Can be directly influenced by the commissioner of a study
 - Product specific data (if possible)
- Background
 - Processes affected by the foreground
 - Data from databases (normally)

Foreground/background – Waste water treatment

“What are the environmental impacts of treatment of waste water from households in a specific area?”

- What would be in the foreground?
- What would be in the background?

Foreground/background – Waste water treatment



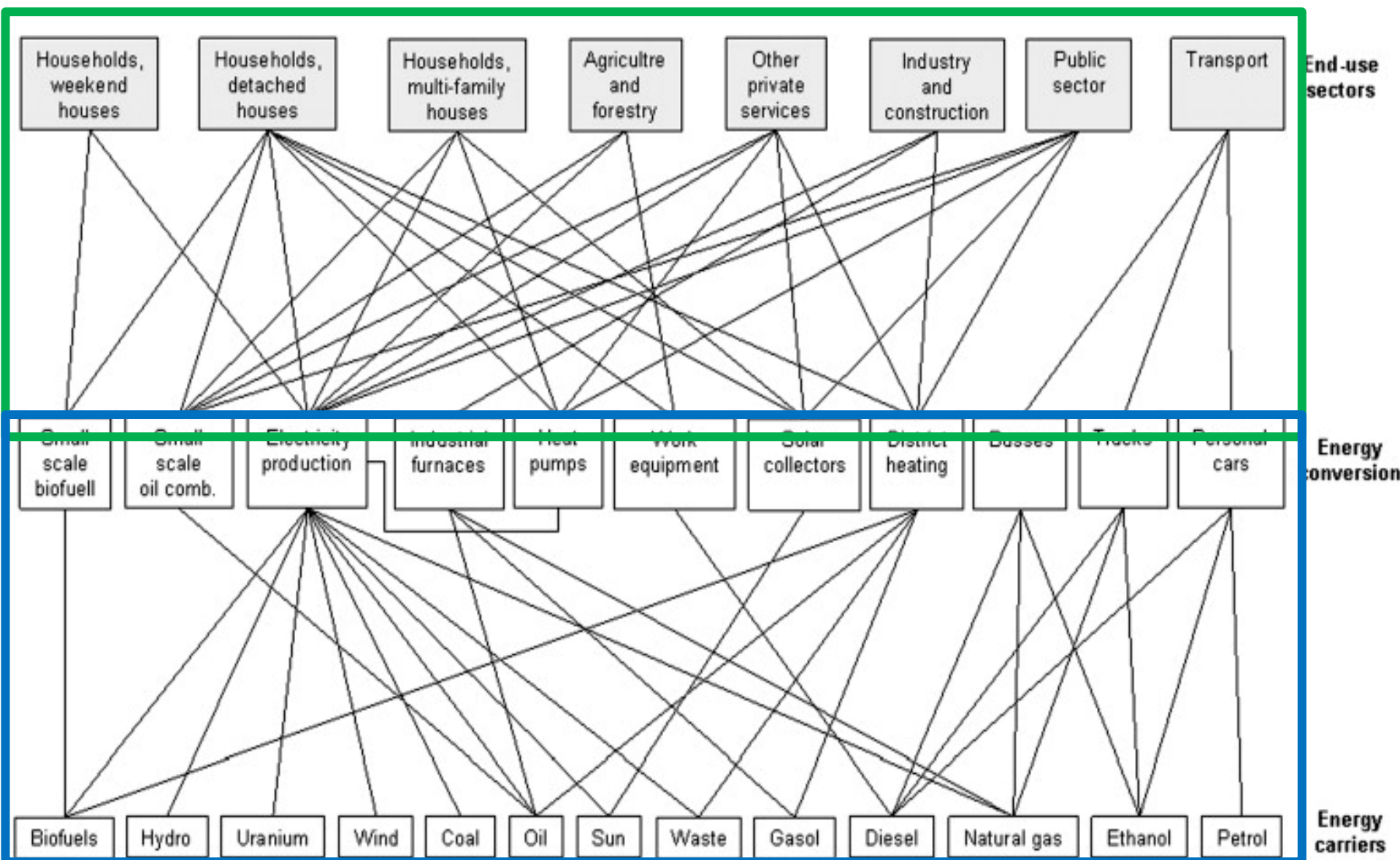
Foreground/background – Municipal energy supply and use

“What are the impacts of current energy supply and use in Finspång today?”

“What are the consequences of measures to reduce energy use in the municipality?”

- What would be in the foreground?
- What would be in the background?

Foreground/background – Municipal energy supply and use



Foreground/background in SimaPro (Example of a product LCA)

- **Foreground, typically**
 - Data defining assemblies (eg. type and amount of materials, transport distances of materials, process energy for assembly)
- **Background, typically**
 - Data defining use phase (eg. electricity use)
 - Design of waste scenario (type of treatment, waste flows, recycling rates)
 - Processes and materials used by Assemblies, Use phase, Waste scenarios

Average vs. marginal data

Average data

- In accounting/attributional/bookeeping LCA
- Represents average burdens for producing a unit of good/service in the system.

Marginal data

- In change-oriented/consequential LCA
- Represents effects of small changes in the output of goods/services from the system.
- Short-term or long-term marginal.
- Requires dynamic modelling of supply and demand.

Average vs. marginal data

ISO

- No specific guidance.

ILCD

- Detailed guidance when to use average/marginal data,
- No guidance how to collect average/marginal data.

Decision support?		Kind of process-changes in background system / other systems	
		None or small-scale	Large-scale
	Yes	Situation A "Micro-level decision support"	Situation B "Meso/macro-level decision support"
	No	Situation C "Accounting" (with C1: including interactions with other systems, C2: excluding interactions with other systems)	

Situation A: attributional (average data)

Situation B: consequential (marginal data)

Situation C: attributional (average data)

Work in projects

- Draw initial flow chart of your case study
- Identify foreground/background processes
- How could you collect case specific foreground data (in a "real" LCA project)?
- Course project are typically attributional LCA. If done as consequential LCA, where would marginal data be most important/make the biggest difference? Why?

Allocation

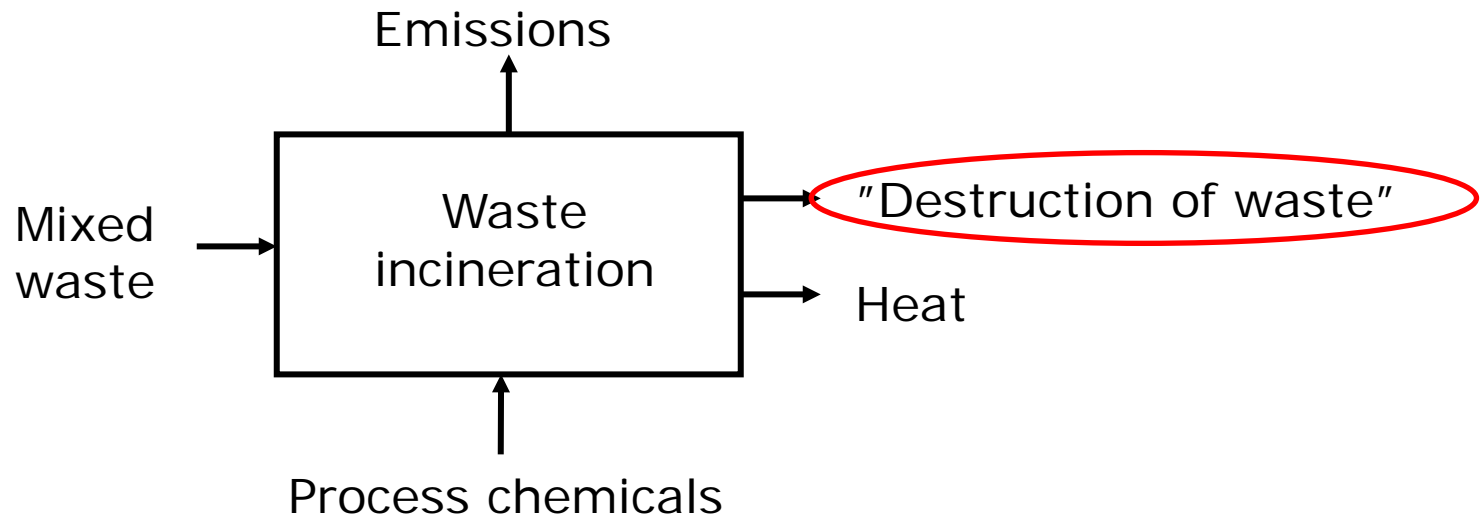
Allocation problems arise when a process performs more than one function.

In that case, burdens need to be partitioned, **allocated**, between the different functions.

3 different types of allocation problems

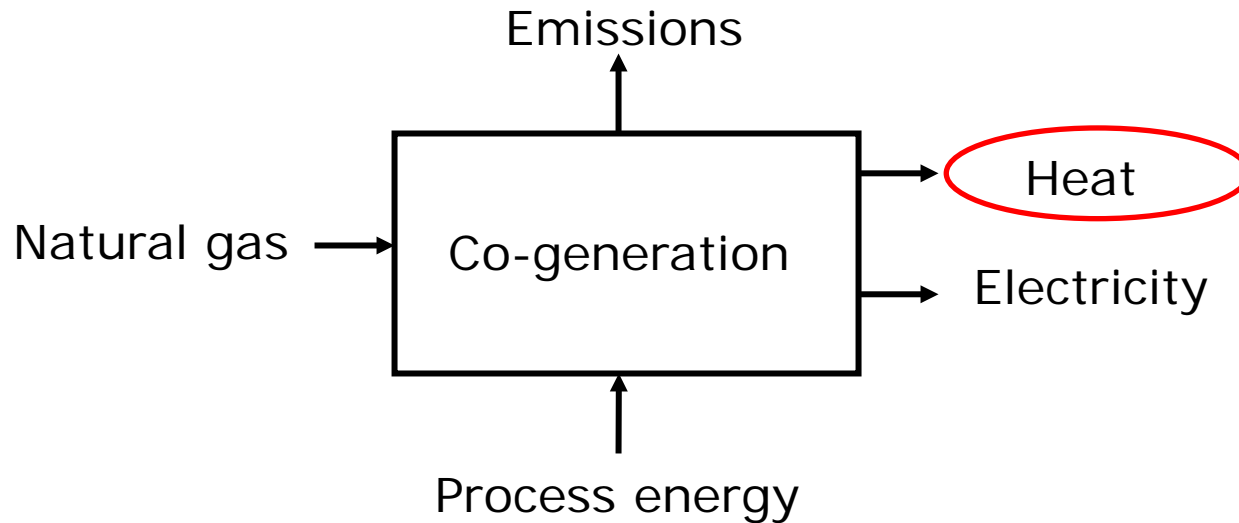
1. Multi-output allocation
2. Multi-input allocation
3. Open-loop recycling

Multi-output allocation



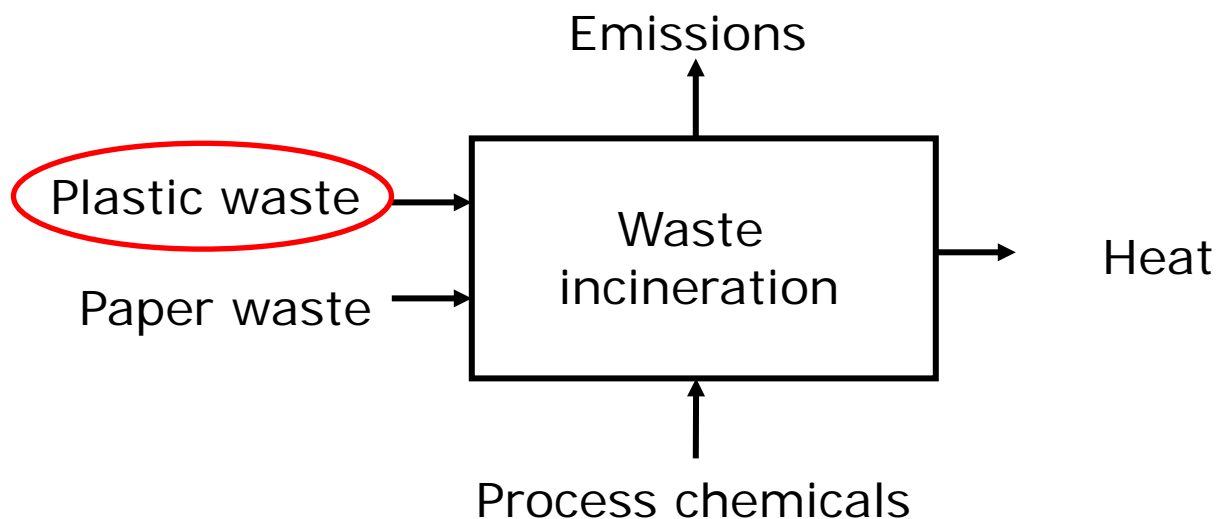
"What are the burdens associated with "destruction of waste"?"

Multi-output allocation



"What are the burdens associated with production of heat?"

Multi-input allocation



"What are the burdens associated with incineration of plastic waste?"

Allocation rules (ISO, ILCD)

Alt 1. Avoid allocation

- increase level of detail in model, or
- expand system boundary to include all affected processes (incl. "avoided burdens approach")

Alt 2. Allocate using underlying physical relationships between products that reflect how inputs and outputs change depending on changes in functions delivered

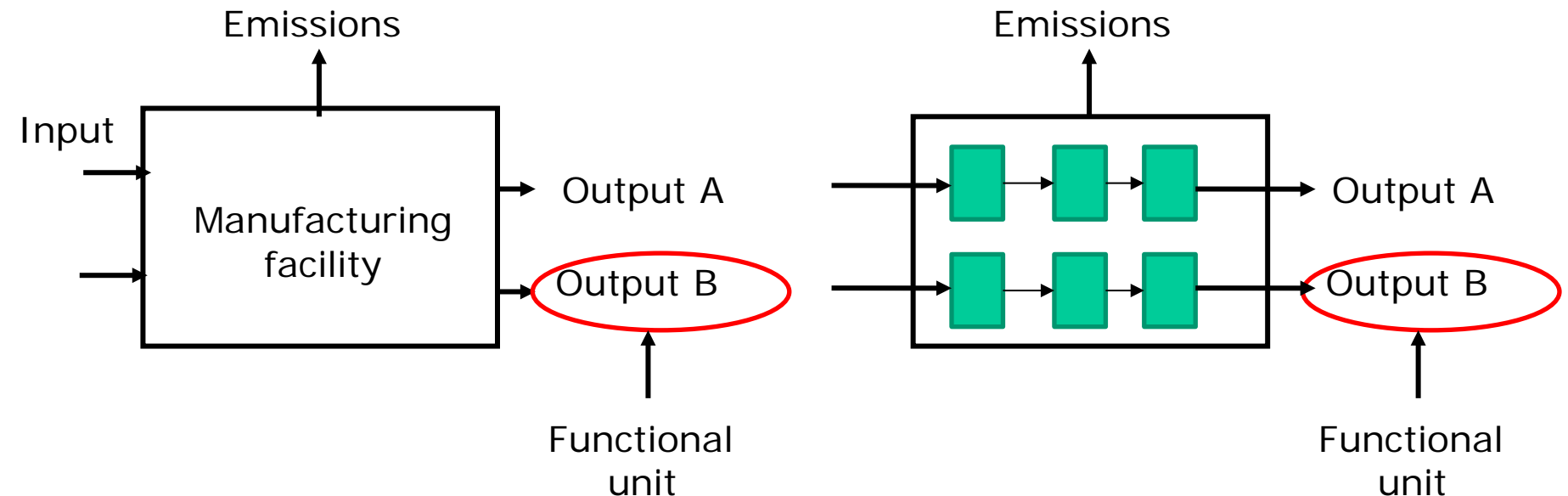
- mass, energy content, material/substance content...

Alt 3. Allocate using other properties of products

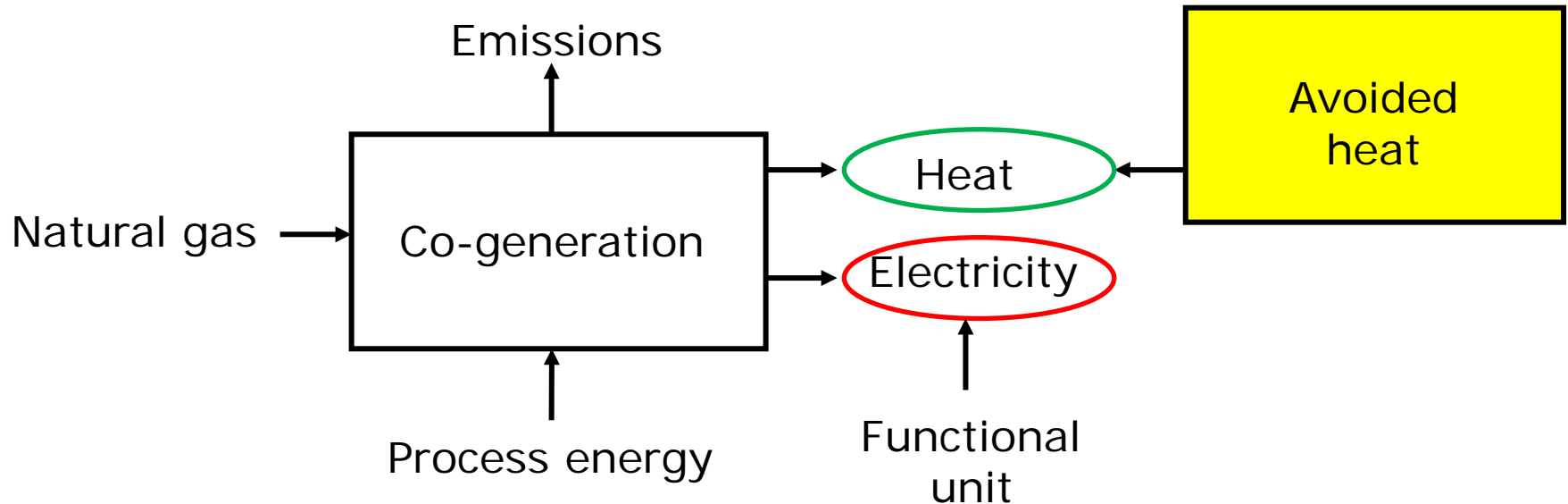
- Mass, energy content, economic value...
- Select based on purpose of study, motivate, document, evaluate!
- Be consistent!

1. Avoid allocation by system expansion

" Increased level of detail"
(= open up the black box)

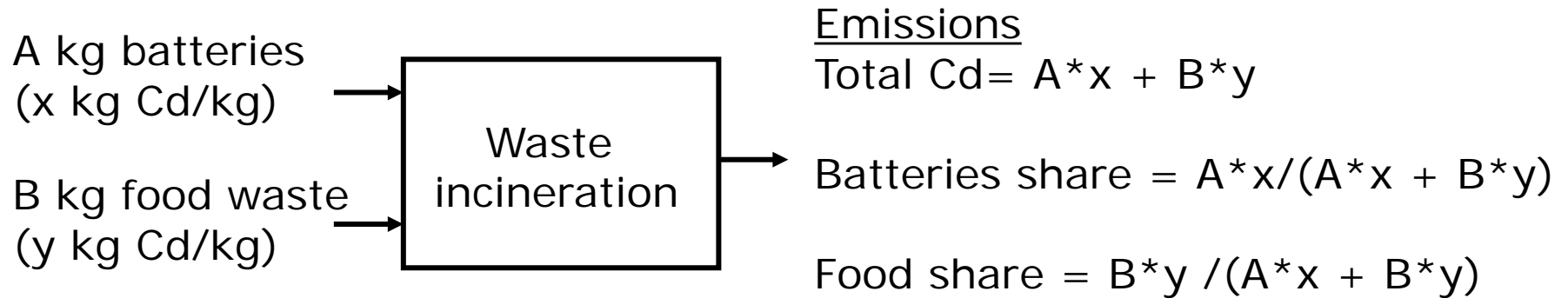


1. Avoid allocation by system expansion "Avoided burdens approach" (= subtract the avoided products)



2. Allocate using physical relationship

(in its simplest form = e.g. mass based allocation)



3. Allocate using economic value

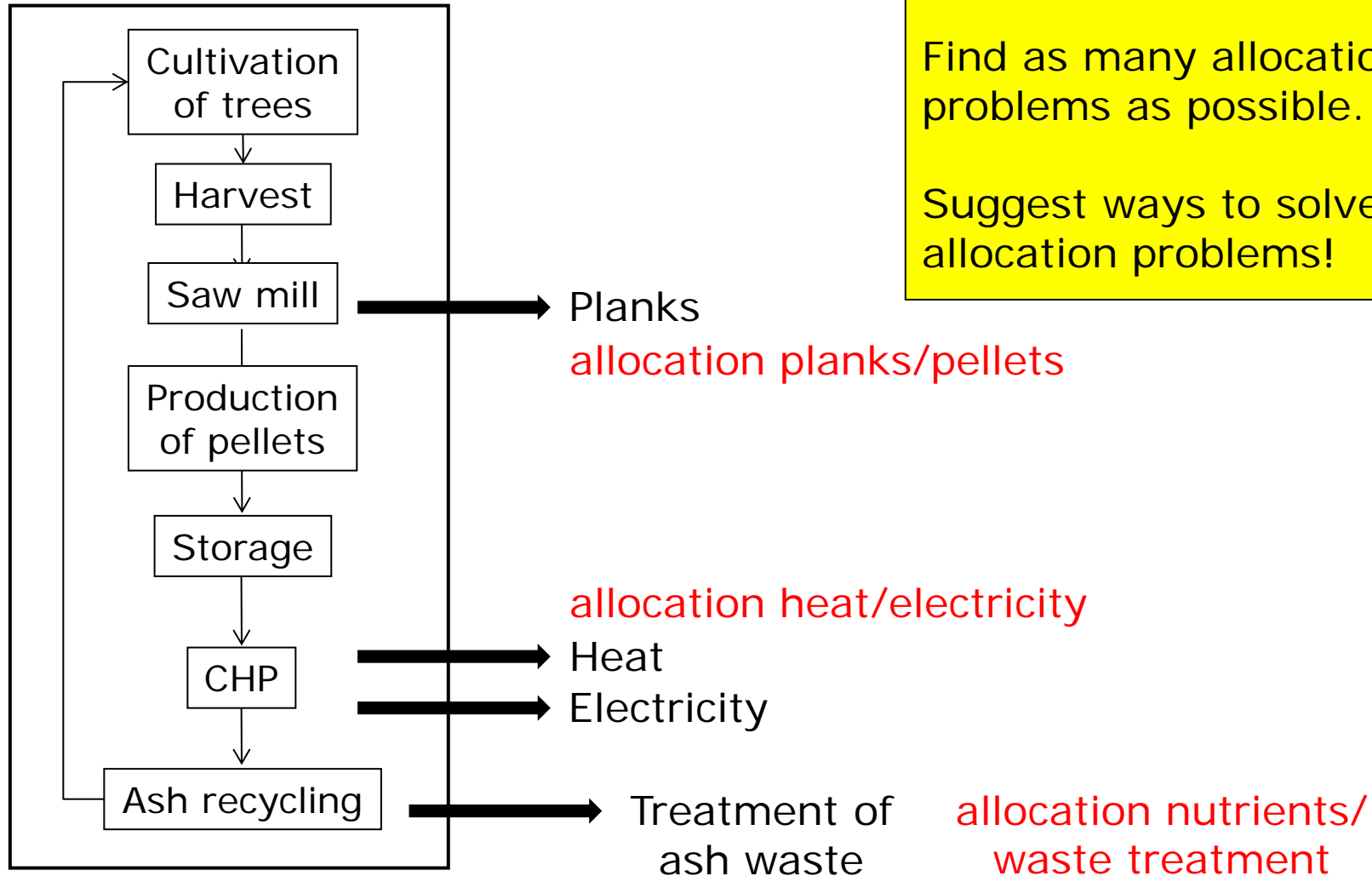
Identical procedure as allocation based on mass (alternative 2), but using economic revenue as basis for allocation.

Work in pairs (5 min)

FU = 1 MWh electricity from pellets.

Find as many allocation problems as possible.

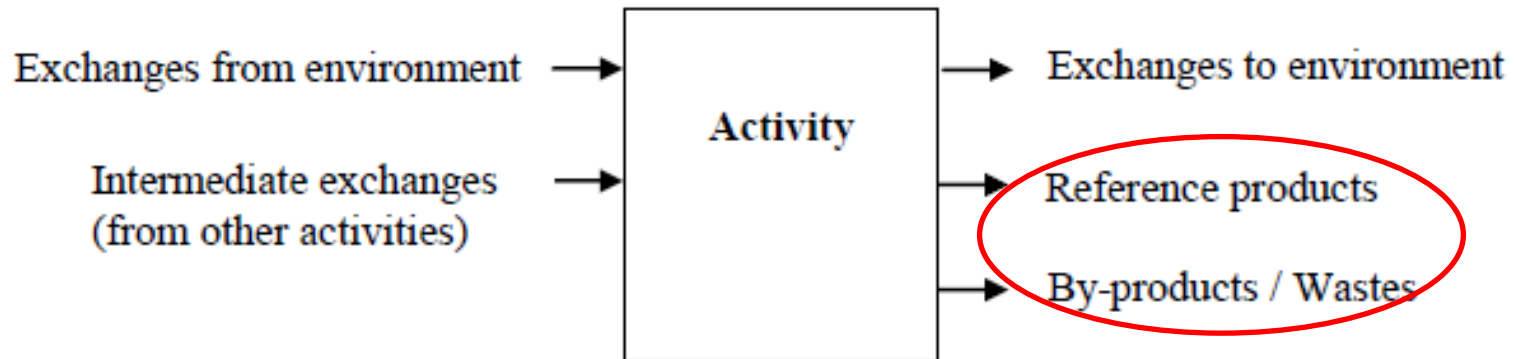
Suggest ways to solve these allocation problems!



Multi-output allocation in SimaPro

- "Energy/Cogeneration/Oil"
 - Allocation by: heat, energy, exergy
- "Energy/Electricity by fuel/waste"
 - Allocation by: price
- "Waste treatment/Incineration/Municipal incineration/Diposal polystyrene"
 - Allocation 100% to waste destruction
 - Cut-off at recycling
 - Avoided burdens must be added manually!!!

Multi-output allocation in SimaPro



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File Edit Calculate Tools Window Help

New material process

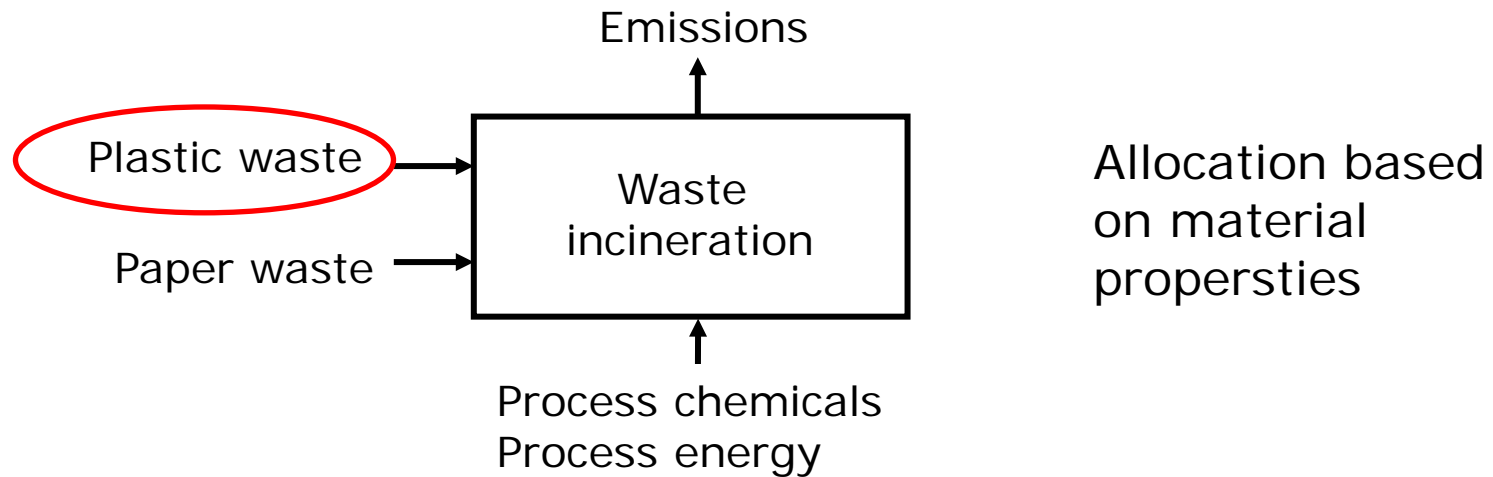
Documentation Input/output Parameters System description

Products

Known outputs to technosphere. Products and co-products

Name	Amount	Unit	Quantity	Allocation %	Waste type	Category	Comment
material A	1	kg	Mass	50 %	not defined	Övriga	mass based allocation
material B	1	kg	Mass	50 %	not defined	Övriga	mass based allocation
(Insert line here)							

Multi-input allocation in SimaPro



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File Edit Calculate Tools Window Help

Copy waste treatment process 'Waste polyethylene {CH} treatment of, municipal incineration | Alloc Def, U'

Documentation Input/output Parameters System description

Products

Waste specification

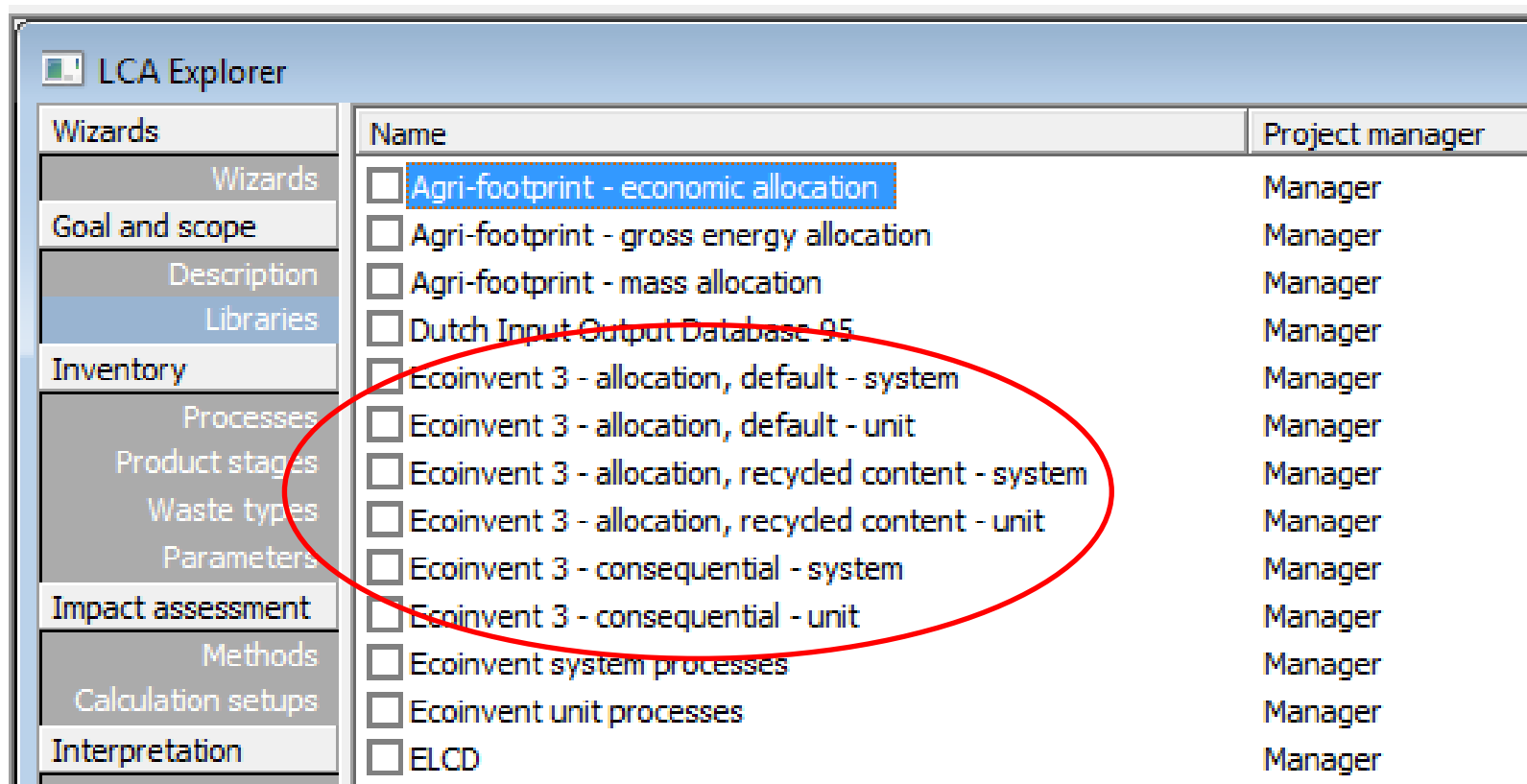
Name	Default material / w	Amount	Unit	Quantity	Category
Waste polyethylene {CH} treatment of, municipal incineration Alloc Def, U	All waste types	1	kg	Mass	Transformation

Known outputs to technosphere. Avoided products

Ecoinvent database

3 versions of the database

- Differ in attributional/consequential
- Differ in allocation procedure



Versions of the Ecoinvent database

"Allocation, default"

- Reflects average supply of products
- Allocation: economic partitioning of multi-product datasets
- Allocation at recycling: system expansion (avoided products) to include credit of recycled material

"Allocation, consequential"

- Reflects consequences of small-scale, long-term decisions
- Allocation: substitution (system expansion) of multi-product datasets

"Allocation, recycled content"

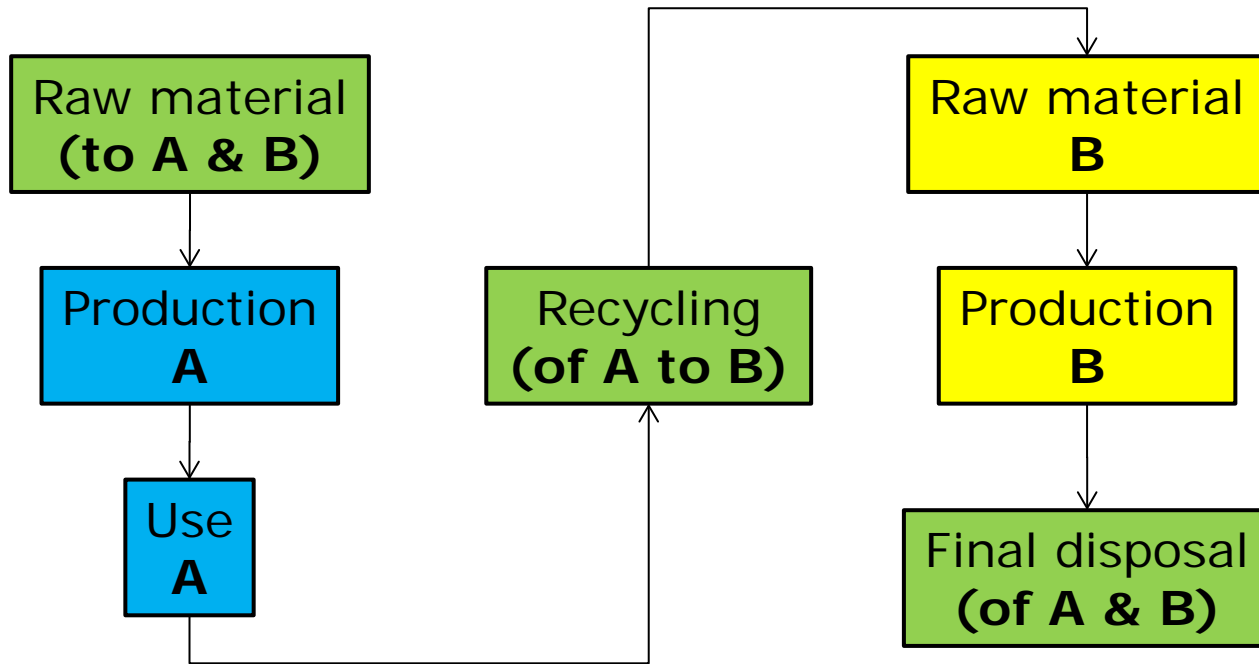
- Reflects average supply of products
- Allocation: economic partitioning of multi-product datasets
- Allocation at recycling: cut-off, ie primary production allocated to primary user of a material

More info: <http://www.ecoinvent.org/database/system-models-in-ecoinvent-3/system-models-in-ecoinvent-3.html>

Work in projects

- Use initial flow chart of your case study
- Identify multi input/output allocation problems in either foreground or background processes
- Suggest allocation procedures to solve these
- How might choice of allocation procedure affect model results?

Open-loop recycling (OLR)



"What are the burdens associated with the life cycle of product A?"

LC burdens of A = Prod A + Use A
+ x% of Raw materials
+ y% of Recycling
+ z% of Final disposal

OLR allocation methods

Concerns:

- Fairness among product life cycles
- Incentive to use recycled material, to recycle, and to design for recycling
- Must add up to 100% over all life cycles (?)

Cut-off method/Polluter pays

- Burdens directly caused by product
- Used in Ecoinvent

50/50 method

- Equal partitioning of Raw material, Recycling, Final disposal

Closed loop approximation (avoided burdens)

- Material recycled to same material, subtract recycled material from input

Avoided burdens may also be used for open loop.

Examples of datasources

- Databases in Simapro
- Other LCA databases
- LCA reports and articles
- Non-LCA scientific literature
- Handbooks
- Contacts with companies/experts
- Environmental reports from companies
- Reports from the Swedish EPA and other agencies

Two types of inventory data

- Process data
- Data from environmentally extended input-output analysis

Input-output analysis (IOA)

- Economic tool
- Used for national accounting
- Illustrates (as matrix) monetary connections between sectors

Environmentally extended IOA

- Intensities (emissions/\$) added to monetary flows
- Key assumption: the intensities are the same within the productgroup
- Comprehensive, but low level of precision
- To use, necessary to know the cost

Databases in SimaPro

Ecoinvent

- Compiled by Swiss Centre for LCI
- (Mainly) Swiss and Western European

ELCD

- European Reference Life Cycle Database
- Compiled by EU level enterprises

Industry Data 2.0

- Compiled by industry associations

LCA Food

- Results of Danish research project

US LCI

- Compiled by US industry, authorities, organisations

Input/output databases (Dutch, EU, DK, US)

Creating your own data set

Inputs

- Resources from nature.
- Products (materials, fuels, electricity, heat, transport etc.) from technosphere (connects to other process sheets).

Outputs

- Products. In case of co-products, allocation or avoided products.
- Emissions to air, water and soil
- Final waste flows (connects to other process sheets).