Interreg Baltic Sea Region

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VillageWaters

LCA methods used in the Village Waters

What does it offer in environmental and economical issues

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Reasons to use LCA

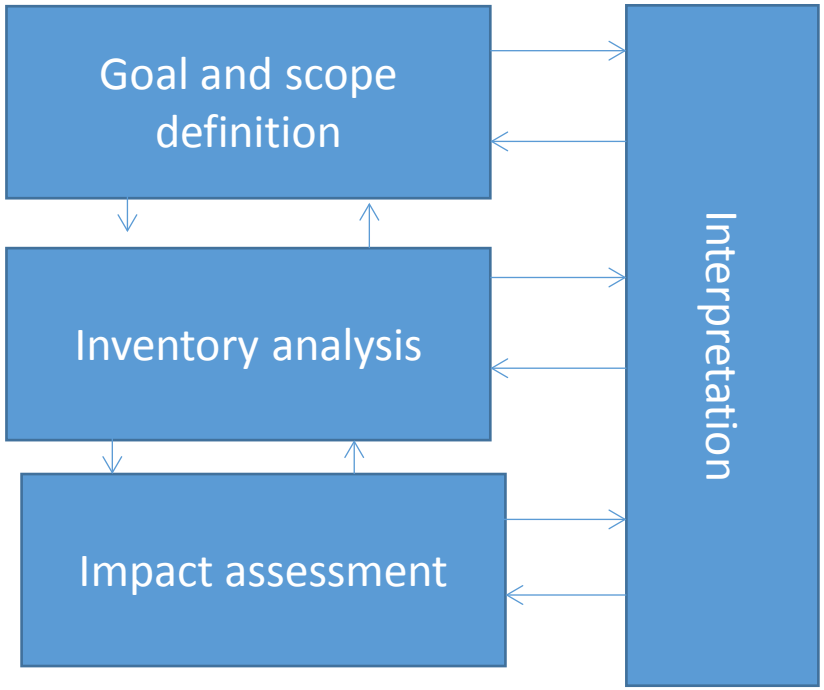
- LCA provides a comprehensive overview of environmental benefits and disadvantages of the studied products system
- All processes and functions within the defined system boundaries are taken into account
- By doing LCA it is possible to investigate many impact classes and compare them to each other
- The whole product chain is investigated, which makes it possible to find hot-spots of the systems and avoid unwanted surprises as well
- LCA has been used very widely for different products and services, such as food products, wood-based products, metals, energy, cars, clothes and even waste water treatment plants.
- LCA results can be used in public communication, decision making and process optimization of industrial companies etc.

Impact classes

- LCA results are usually a combination of different impact classes, which are partly caused by emissions and partly used amount of different capacities
  - Climate impact (Carbon footprint)
  - Eutrophication of waters
  - Terrestrial eutrophication
  - Acidification
  - Tropospheric ozone formation
  - Ozone depletion
  - Eco-toxicity and human toxicity
  - Land use
  - Water use (Water footprint)
  - Biodiversity
  - Energy use
  - Resource depletion

Life Cycle Assessment phases

- **1) Goal and scope definition:** methodological issues defined
- **2) Inventory analysis:** data collection and calculation of emissions
- **3) Impact assessment:** assessment of environmental impacts, characterization of emissions
- **4) Interpretation:** assessment of the results in relations to the aims defined in goal and scope definition phase
- **Iterative process**: sometimes it is inevitable to go back to earlier stages when the investigation goes further



Threats of major environmental impacts

- Climate impact (Carbon footprint)
  - Is a global environmental impact class and globally important
  - Caused by increased amounts of greenhouse gases in the atmosphere
  - Will increase the temperature of the earth from two to six degrees
  - The changes in precipitation cause draught and floods
- Eutrophication impact
  - Is a regional impact class: especially Baltic Sea is very sensitive to eutrophication
  - Caused by nitrogen and phosphorus nutrients ending to the lakes and the sea
  - Increases the amounts of algae
  - Leads to oxygen depletion

Functional unit

- Functional unit (FU) defines what is the function of the system, e.g.
  - m3 waste water treated
  - Waste water treatment for one year
- FU have to be representative to the situation: possible functional units are also removed amounts of BOD and nutrients.
- It is important that FU describes well all the systems which are compared to each other – for example for food. products nutritional aspects must be taken into account in comparisons.

Allocation

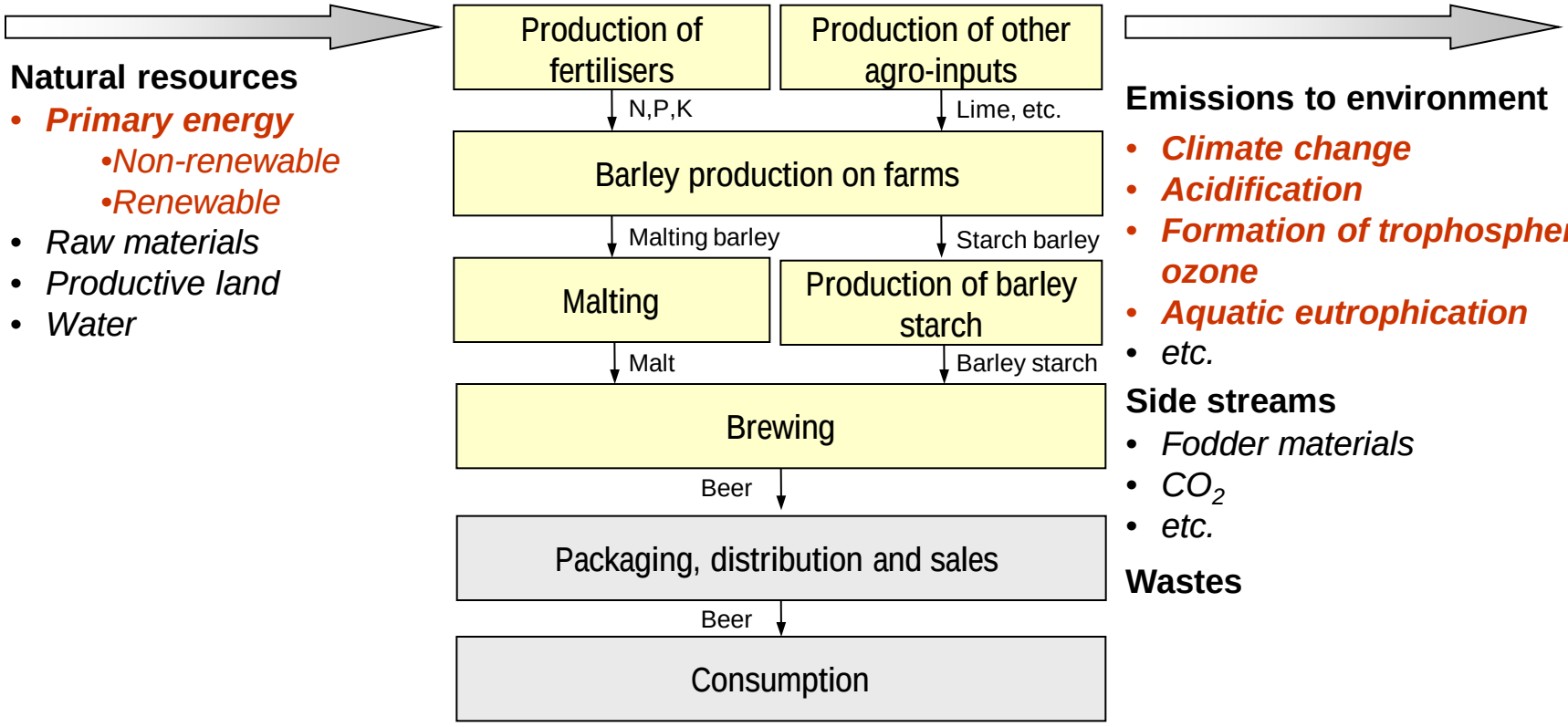
- If the same system produces multiple products, there is a need to divide inputs and emissions between those systems.
  - Not relevant in most of our cases, but e.g. in excavation process many functions can have benefit from the process (wastewater, clean water, electric cables etc.)
- Different allocation methods
  - Economic allocation
  - Mass/Energy allocation
- Allocation can in general have strong impact on the final results and that is why allocation methods has to be defined clearly.

System boundaries

- System boundaries must be defined well so that all relevant inputs and outputs are going to be inventoried.
- Cut-off criteria is used to exclude negligible parts of life-cycle. The sections to be cut-off must be assessed al least cursorily (screening LCA) before cutting them off in order to make sure that the cut-offs do not bias the results.
- In this project construction, use and disposal phases of waste water treatment systems are inventoried, taking into account transports, emissions, purification efficiencies and material and energy flows.
- The study would be incomplete, if only use phase would be included.

Barley-malt-beer chain and the basic analysis method

Life-cycle assessment (LCA)



Natural resources

- ***Primary energy***
  - *Non-renewable*
  - *Renewable*
- *Raw materials*
- *Productive land*
- *Water*

Emissions to environment

- ***Climate change***
- ***Acidification***
- ***Formation of trophospheric ozone***
- ***Aquatic eutrophication***
- *etc.*

Side streams

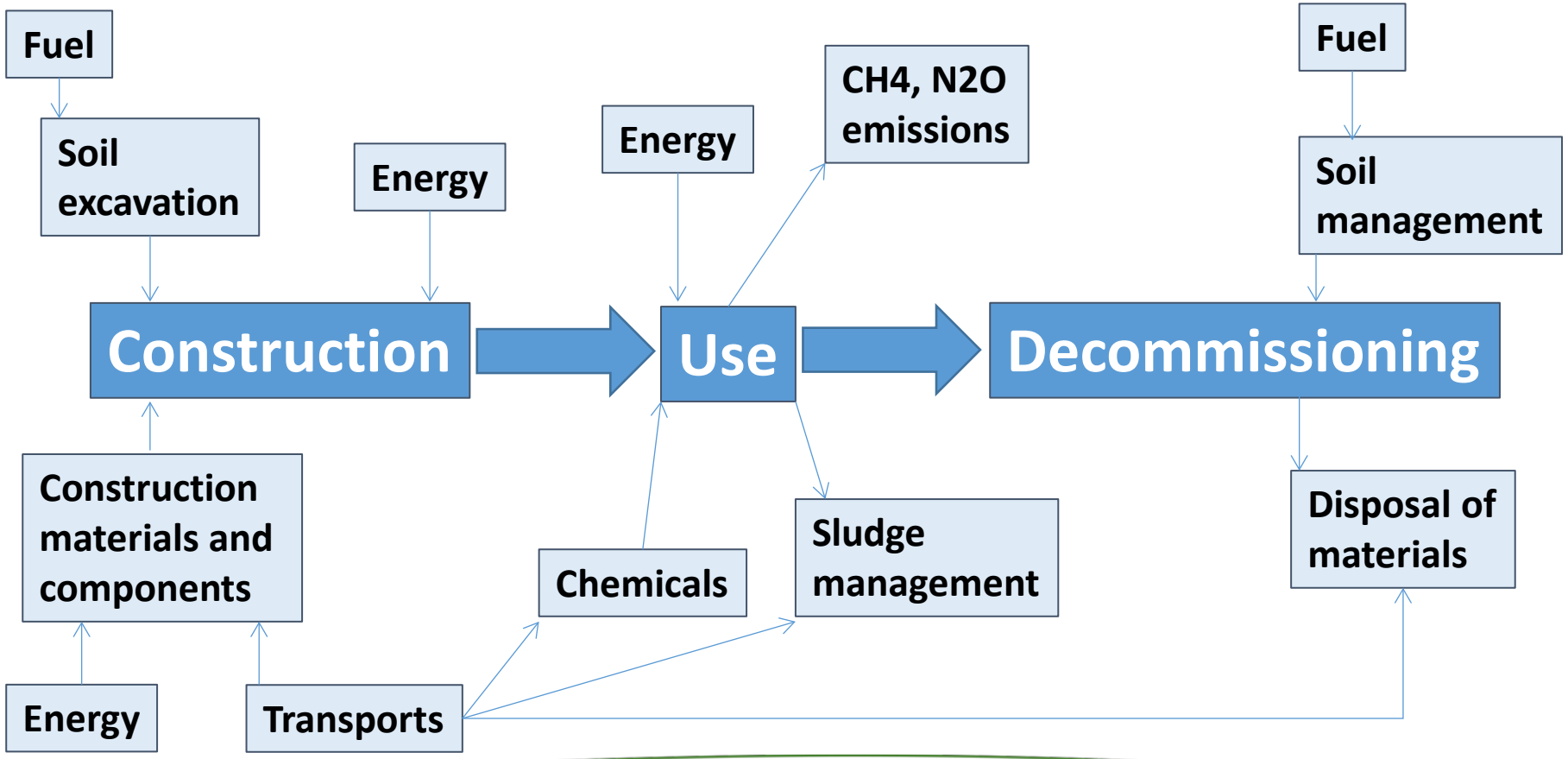
- *Fodder materials*
- *CO_2*
- *etc.*

Wastes

Functional unit

- *Daily consumption of beer in Finland = 0,232 l (2004)*

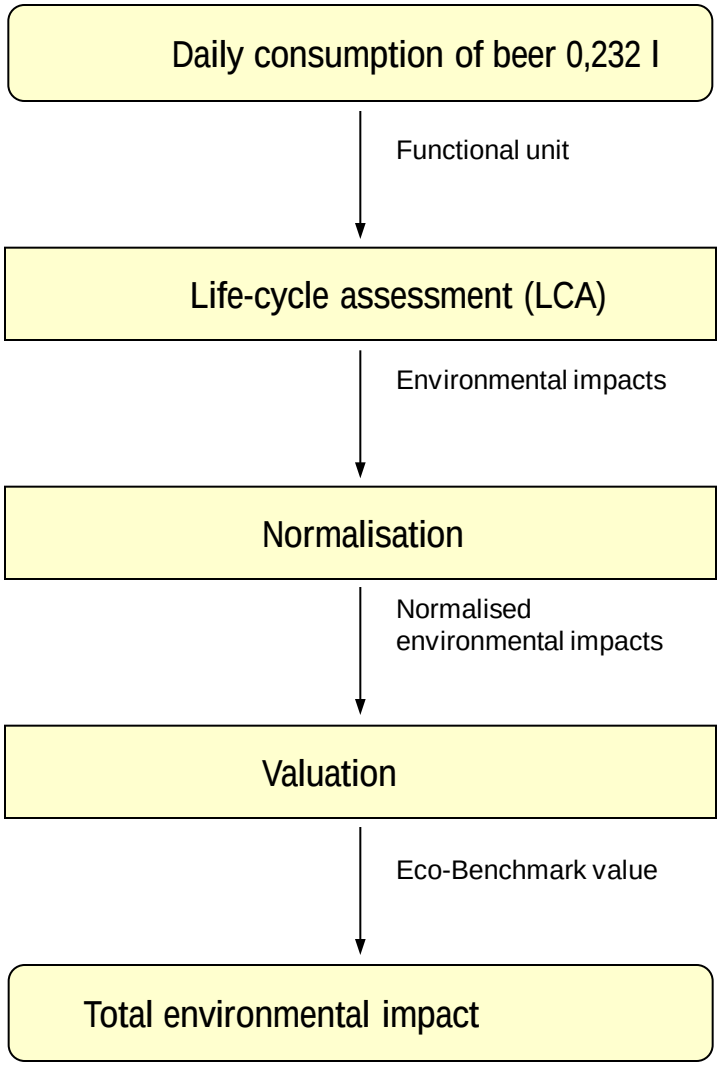
System boundary of waste water treatment system



How the work is done in WillageWaters?

- First, data is collected mainly from manufacturers and resellers of technologies.
  - The data consist of capacities, purification efficiencies, chemical, energy uses, materials etc.
- Emissions are calculated using emission factors obtained from LCA databases
- Emissions are classified to emissions which cause climate impact and those that cause eutrophication.
- Calculated emissions are characterized by multiplying them with characterization factors specified for them for each of the impact classes assessed.
  - Characterization for the climate impact takes into account radiative forcing of carbon dioxide and other greenhouse gases
  - For eutrophication, characterization takes into account the nutritive properties of nitrogen and phosphorus emissions in the aquatic environment (Baltic Sea) where the emissions end up. In calculation it is taken into account how big a part of each nutrient ends up to the Baltic Sea.
- In normalization the impacts are proportioned to average emissions in the country per capita and a day. For normalization, impact results are calculated on the same per capita and per day basis
- Finally, the normalized impacts are weighted and compared to each other in valuation stage of the total assessment procedure.

Method for the total environmental impact



Environmental inventory and characterisation

- *Primary energy*
- *Climate change*
- *Acidification*
- *Formation of trophospheric ozone*
- *Aquatic eutrophication*

Per capita environmental impacts of Finland

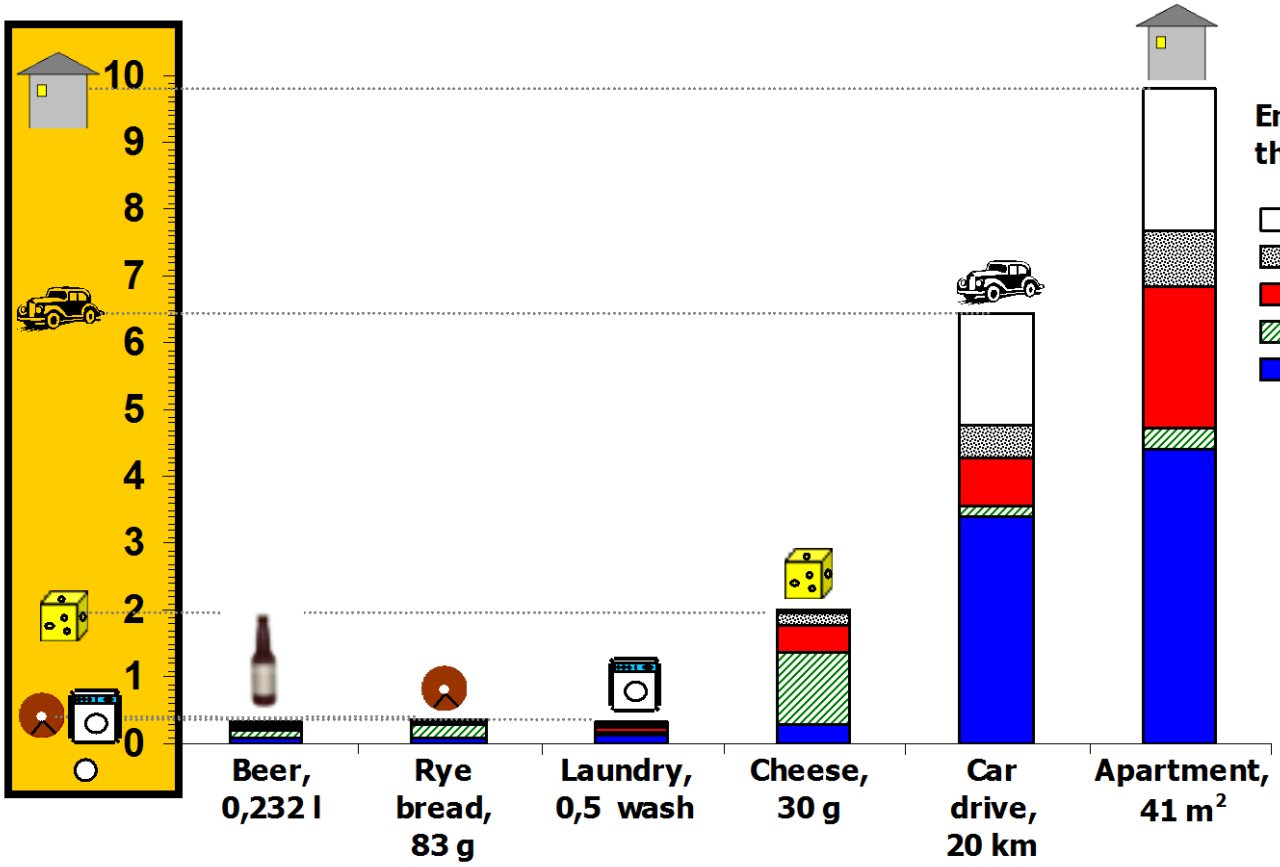
- *Primary energy,* 759,3 MJ / a, person
- *Climate change, 43,1 kg CO2 eq* / a, person
- *Acidification, 0,05 AEeq* / a, person
- *Acidification, 0,10 person ppm hour* / a, person
- *Aquatic eutrophication, 0,012 kg PO4- eq* / a, person

Relative importances for environmental loading (Finland)

- *Primary energy, 18,6 %*
- *Climate change, 30,0 %*
- *Acidification, 15,7 %*
- *Formation of trophospheric ozone, 10,0 %*
- *Aquatic eutrophication, 25,7 %*

Beer in Eco-Benchmark

100 = daily per capita environmental impacts of Finland
64 = daily per capita environmental impacts of consumption



Environmental impacts and their weightings (in parentheses):

- Primary energy consumption (0,18)
- Formation of trophospheric ozone (0,10)
- Acidification (0,16)
- Aquatic eutrophication (0,26)
- Climate change (0,30)

Cost-benefit analysis

- Cost-benefit analysis takes also into account the whole life-cycle as well as LCA environmental impacts.
- Investment costs and use costs are included.
- A correct service life estimate is important also for the economic assessment of the systems.
- The results are also proportioined to average daily consumption per capita in each country.

Conclusions

- The LCA methodology will provide a comprehensive overview of the environmental and economic impacts of different technological solutions of scattered dwelling.
- By investigating the whole chain it is possible to find the hot-spots and use this information for decision making.
- Assessing the length of the service life of the system is important for assessing the significance of construction-phase and use-phase. A correct service life estimate is important also for the economic assessment of the systems.
- Normalization helps to put the results into right perspective by changing the absolute results to relative scale by making them proportional to the per capita and year averages in each country.
- Valuation produces the total impacts for the comparison of different systems to each other.

Thank you!

Questions?

https://villagewaters.eu/

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