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Environmental impacts of using residues from food processing

Niels Jungbluth
ESU-services Ltd., Schaffhausen, Switzerland
www.esu-services.ch

Pathways of zero net GHG emission in the Food Sector
BFH-Master "Circular innovation & sustability"
Berner Fachhochschule, 07.12.2023

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- What is an LCA?
- Waste or residue? Polluter pays principle
- Allocation for recycling
- Usage of food processing residues
- Example whey usage
- Conclusions

Dr Niels Jungbluth

We assist you

Samuel Solin, Christoph Meili, Maresa Bussa, Martin Ulrich

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All economic sectors coved

We provide…

- Full studies, e.g. ISO-compliant LCAs, OLCA, CF, EPD & PEF
- Simplified assessments, e.g. Screening LCA, ecoprofiles, key parameter models, etc.
- Databases and single datasets (data-on-demand)
- LCA software, training & coaching
- Critical peer reviews, validation & verification

LCA METHODOLOGY

Life Cycle Assessment

- Balance of all in- and outputs
- Life cycle from cradle to grave
- Assessment of different environmental impacts (e.g. climate change, eutrophication, summer smog)
- Improvement and comparison of production processes

Life cycle assessment = from cradle to grave

Impact of driving 1km

Brainstorming question

- Which food processing residues do you know?
- Which types of usage do you assume?

➢ Provide your answers in the chat

Examples of food processing residues

- Couple products:
  - Whey from cheese making
  - Soybean meal from oil pressing
  - Apple peels from making dried apples
- Food waste:
  - Unsold bread from supermarket
  - Used cooking oil sold by McDonalds

➢ Residues can be couple products or food waste

Competing usages of biomass residues

- Food (maybe upgraded)
- Fodder for animals and insects
- Fertilizer (compost)
- Biomaterials (e.g. leather from apple peels, glycerine, oils, ethanol)
- Processed materials (bioplastics, biochemicals)
- Energy carrier (biodiesel, biogas, ethanol)
- Energy (heat, electricity)
- Waste management with energy and substance recovery (MSWI, WWTP with sludge digestion, direct incineration, partly recovery e.g. of phosphorus)

➢ Often competing usages and many ideas to valorise residues

Why do we need allocation?

PROBLEM DESCRIPTION

Allocation: initial position

- Attribution of process inputs and emissions to two or more products and/or services that are jointly responsible for the inputs and emissions (couple products and residues)
- We only want to model environmental impacts of one of the outputs
- The environmental impacts need to be divided/allocated to the different outputs

Allocation problems occur at ...

- Processes delivering more than one product:
  - Refinery
  - CHP (combined heat and power)
  - Dairy
  - Biodiesel (diesel, rape meal, glycerine)
- Recycling of materials or energy
  - Waste incineration
  - Metals recycling
  - Use of residues

Allocation in multioutput processes according to ISO 14044

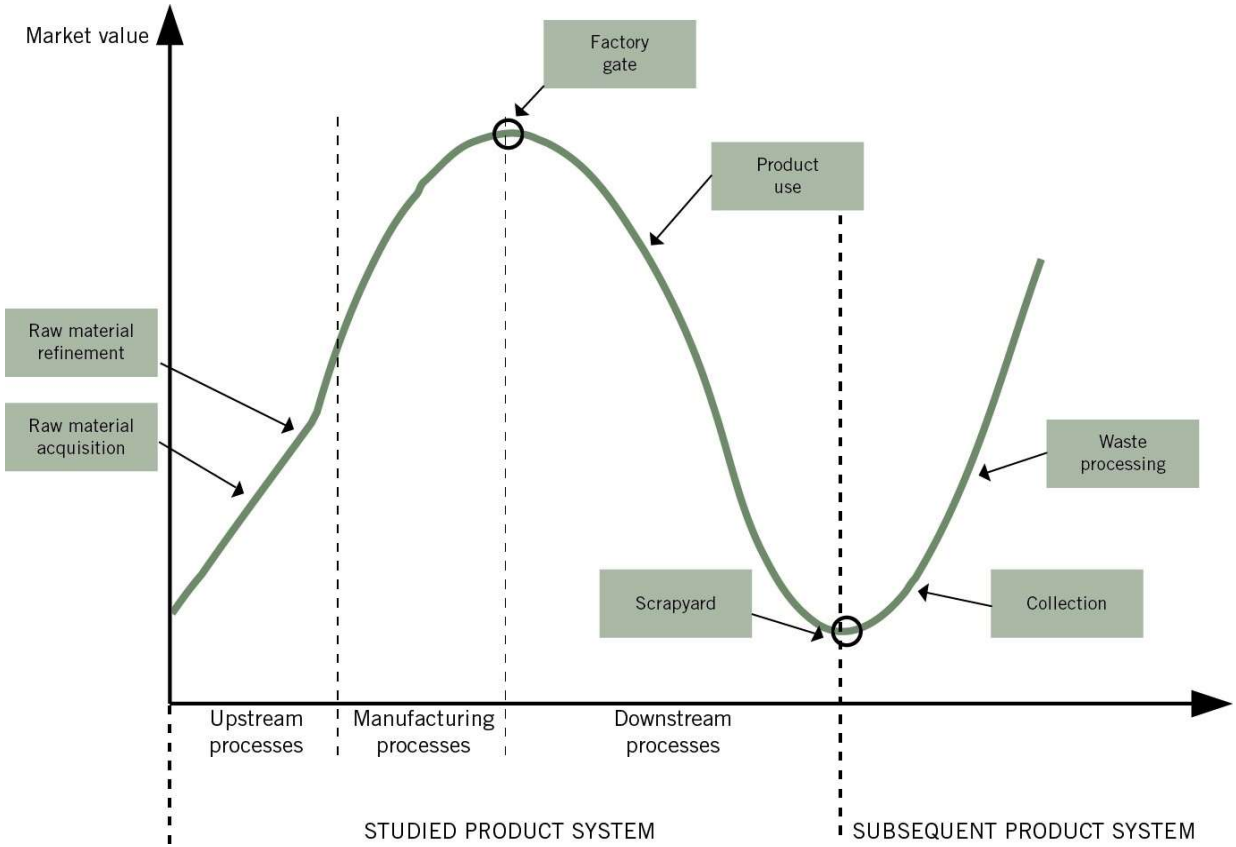
Three steps procedure:

1. Avoid allocation by
   - increasing the level of detail
   - expanding the system
2. Allocation according to physical relationships
3. Allocation according to other relationships (e.g. economic, exergy, mass, etc.)

Is the food processing residue a waste or a product?

POLLUTER PAYS PRINCIPLE

Market value in the course of the life cycle



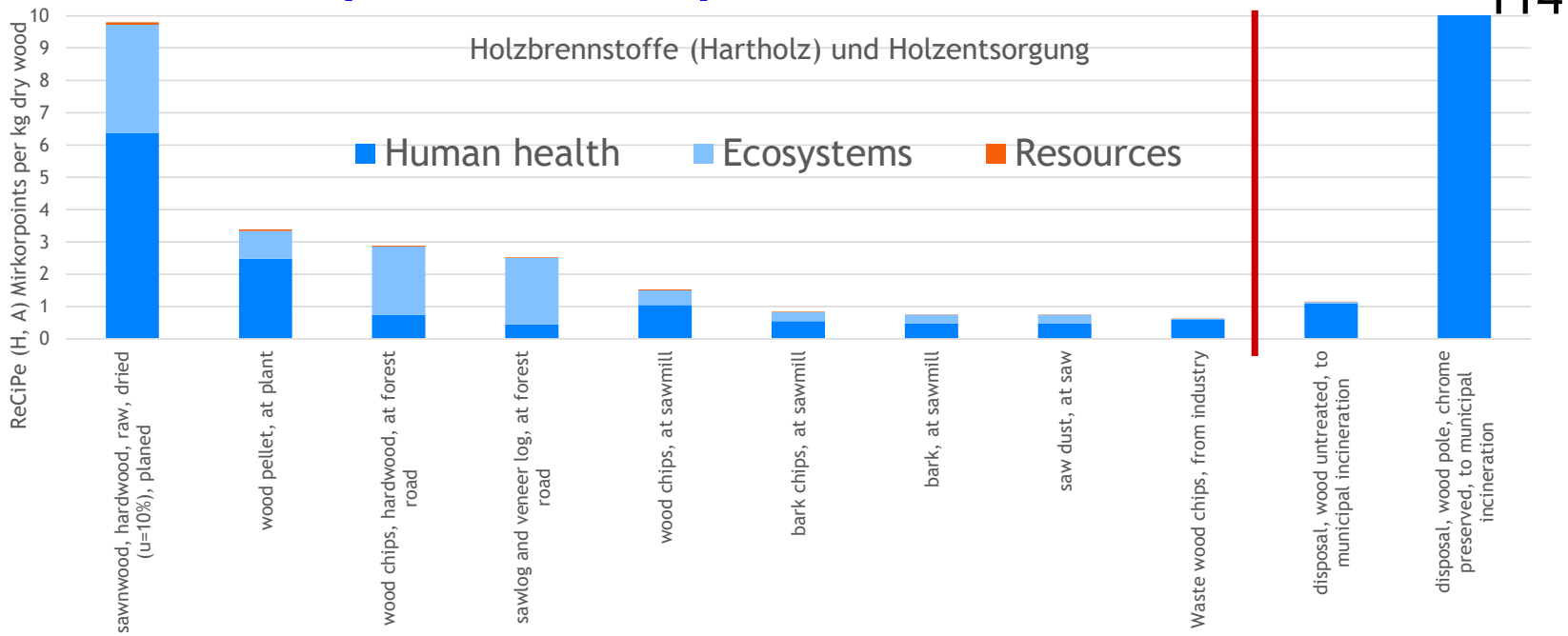
Polluter Pays Principle

- Waste is not defined generically in LCA but by the price of the residue material
- Analogous to the economic business balance sheet
- Operation bears all costs (=expenses). These appear in the LCA on the environmental impact side of the business.
- Operation sells products and services (=revenue). Environmental impacts are passed on to the buyer
- 100% rule to maintain a correct overall balance

PPP broadly supported in the LCA community

- Allocation of environmental impacts in the production and treatment of residues is an allocation problem according to ISO 14040/44 (other criteria)
- Specification PPP in EN 15804 to define end of waste
- Economic allocation is found in many DS of the ecoinvent database (e.g. wood products, biofuels and materials, animal feed, food processing)

Example wood qualities in ecoinvent



- Ecosystem (land use) = estimation of forestry load depends on economic value and further processing, minimum share of forest also in sawdust
- Waste wood only bears load from processing and chips

Price of residues are influenced by

- Demand of the market and there for its usefulness (ideally)
- Prices of alternatives on the market (e.g. oil price)
- Subsidies and legal requirements in all forms
- LCA results for using residues (how beneficial for the environment)

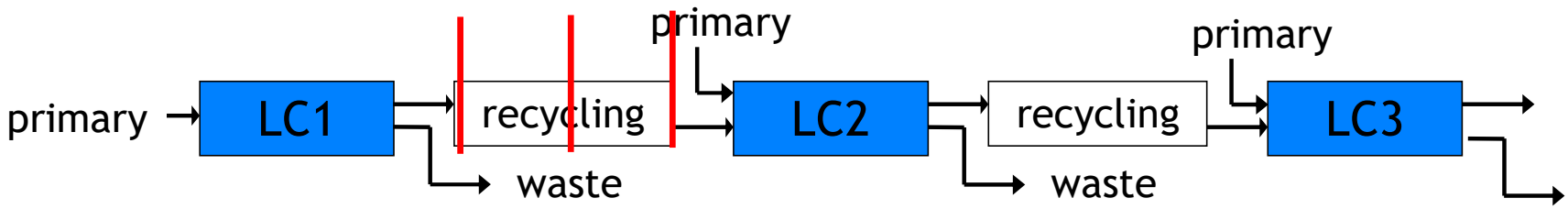
Cut-off or avoided burden approach?

ALLOCATION IN RECYCLING

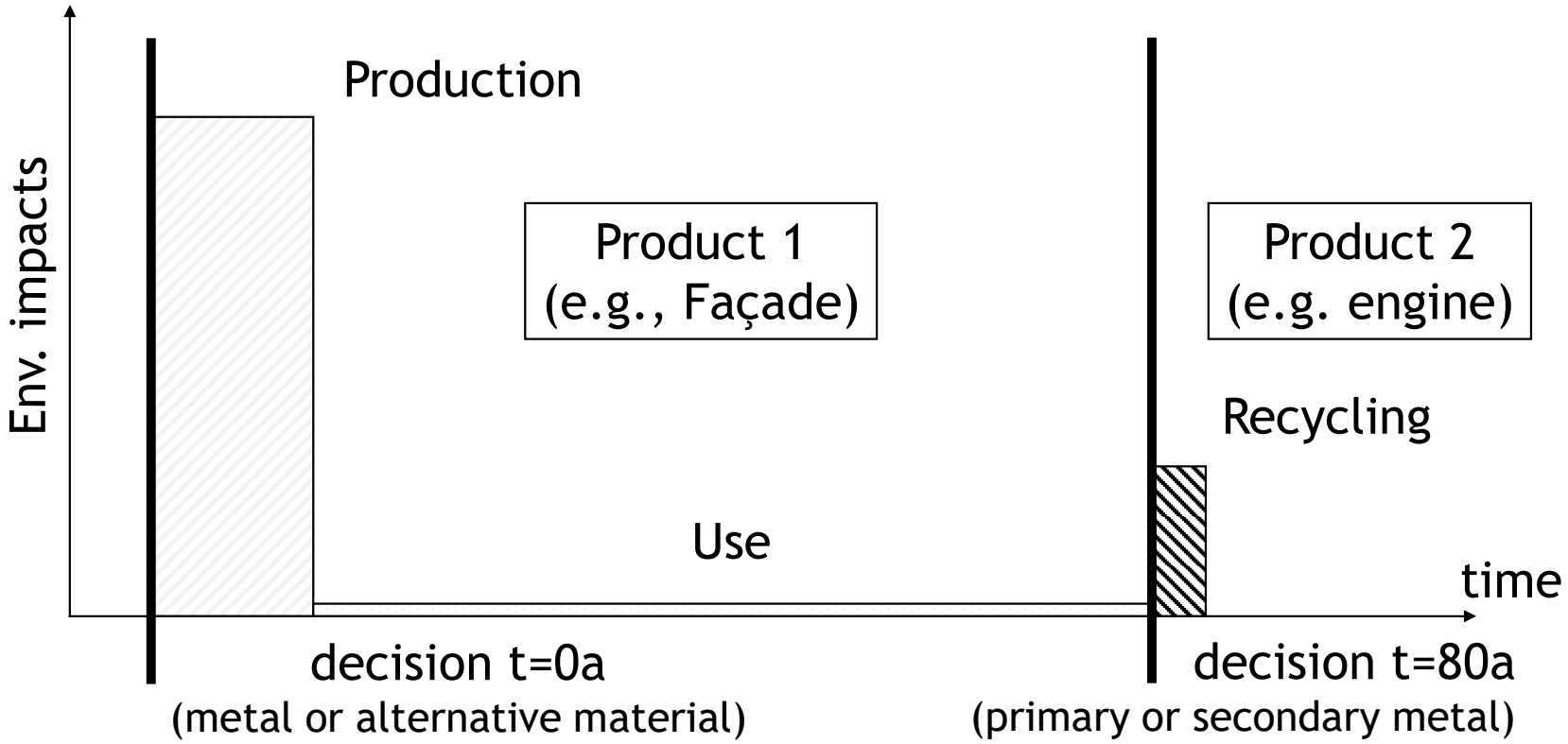
End of life Allokation

Who gets the credits?

1. LC1 (avoided burden)
2. LC2 (cut-off, recycled content)
3. Shared credits



Cut-off approach

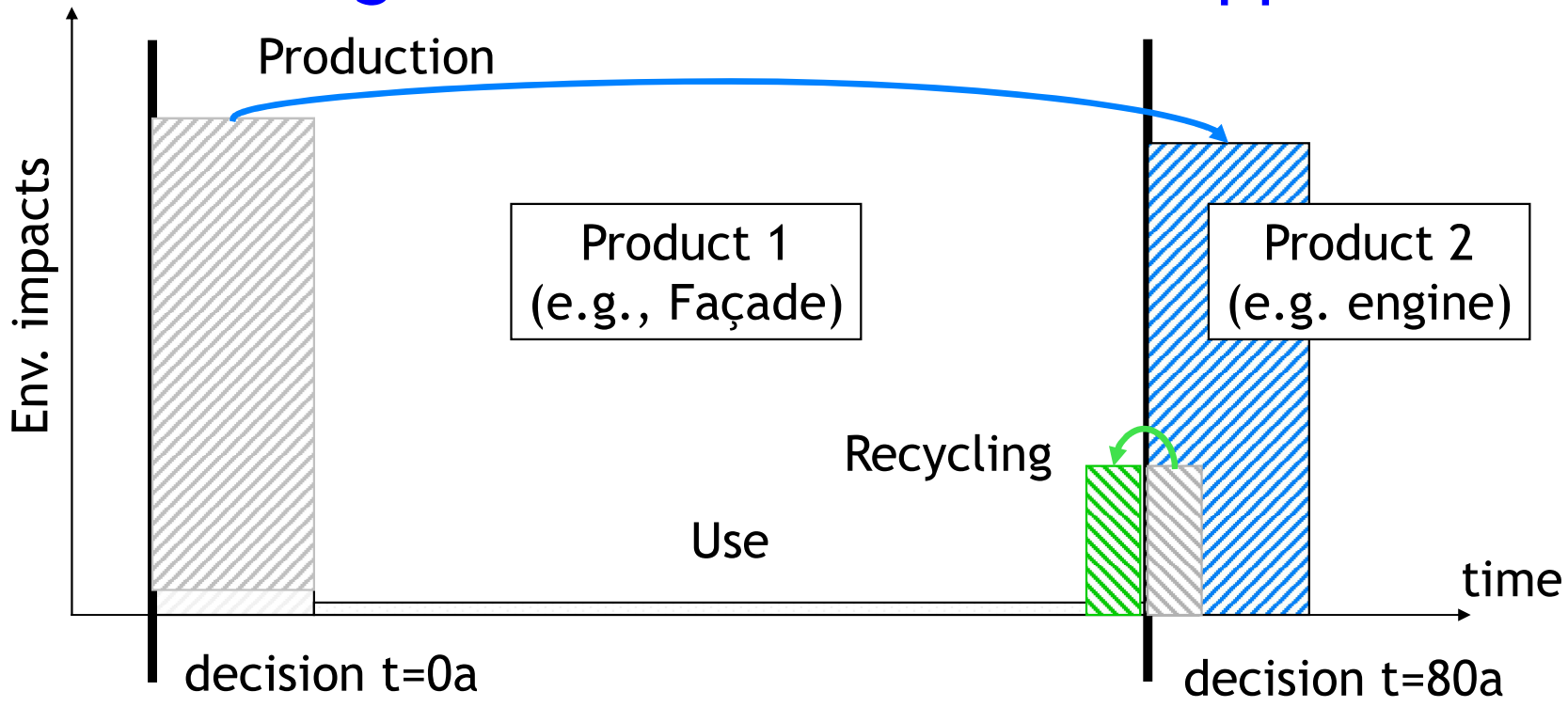


➢ PPP with zero value at the point when recycling starts

Avoided burden approach

- Recycling avoids manufacturing of primary product
- All avoided expenses and emissions are completely attributed to the product that delivers the basic new product after its life
- E.g. avoided burdens of fodder if processing residues can be used integrated in the LCA of the process producing the residue

Environmental impacts modelled according to the avoided burden approach



USE OF WHEY FOR HUMAN CONSUMPTION

Problem setting

- Whey is a by-product of cheese making
- So far often used as fodder
- Proteins would also be suitable for human consumption

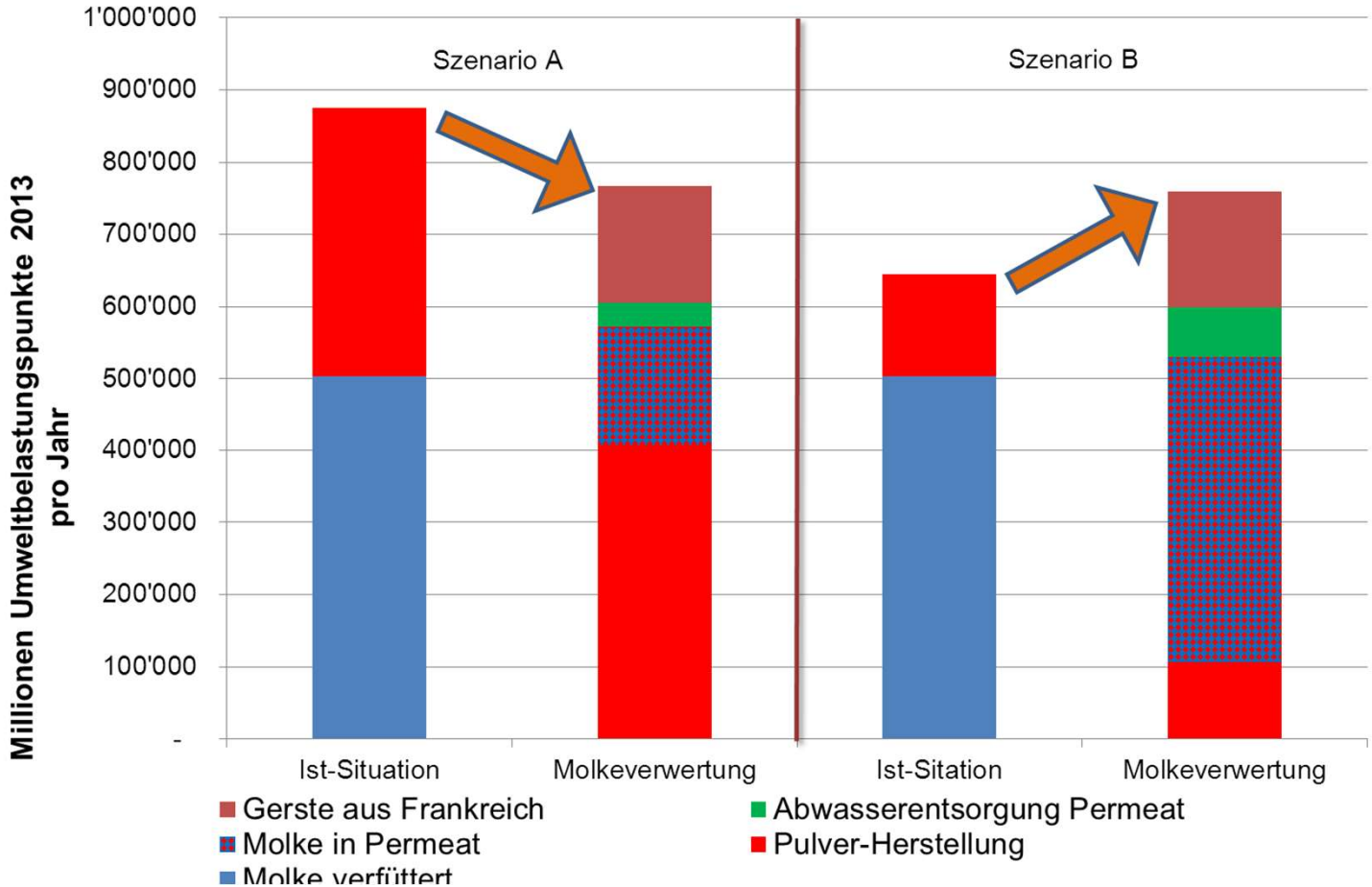
➢ Idea use whey proteins for human consumption

Szenarios

- Use of whey as pig feed and milk powder for human consumption (base case)
- A: Production of whey protein powder (WPC 35) and whey powder, import cereals for pigs
- B: Production of whey protein powder (WPC 65), import cereals for pigs

➢ Not covering direct replacement of animal proteins

Results


Millionen Umweltbelastungspunkte 2013 pro Jahr
1'000'000
900'000
800'000
700'000
600'000
500'000
400'000
300'000
200'000
100'000
-
Szenario A
Szenario B
Ist-Situation
Molkeverwertung
Ist-Sitation
Molkeverwertung
Gerste aus Frankreich
Abwasserentsorgung Permeat
Molke in Permeat
Pulver-Herstellung
Molke verfüttert

Influencing factors for the LCA of using residue

- Allocation problems
  - Waste or residue?
  - Allocation of impacts from the 1st life cycle of food product to the 2nd usage
  - Avoided burden: Which alternatives are considered?
  - Apply PPP
- Efforts (and impacts) of upgrading and valorisation
- Functional unit: What do we compare with each other
- LCA results influence market and increasing prices rise impacts

➢ LCA studies cannot give a clear guidance for all possible cases

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In case of any questions, please contact:

Dr. Niels Jungbluth, CEO - Chief Executive Officer
ESU-services Ltd. - fair consulting in sustainability
Vorstadt 10
CH-8200 Schaffhausen
www.esu-services.ch
tel +41 44 940 61 32
jungbluth@esu-services.ch