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Milk Processing

Life cycle assessment of a detailed dairy model & recommendations for the allocation to single products

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Content of presentation

- LCA dairy model
  - Assumptions, build-up
- Two topics
  - A: Dairy operation
    - Analyses of process stages
  - B: Allocation of environmental impacts to dairy products
    - Global warming potential per kg of dairy product
    - Comparison with allocation of Feitz et al.
  - For each topic, goal, scope, methods, results and interpretation is shown

LCA dairy model

- Model assumptions
  - 600'000l raw milk processed per day
  - Products: UHT milk, yogurt, cream, concentrated milk
- Detailed model build-up
  - More than 40 sub-processes in the dairy modelled
  - Based on literature and estimations by dairy experts
  - Complemented with additional inputs to include the dairy operation from gate to gate
  - Allocation of raw milk separation with milk solids

Goal A

A) Which process stages of dairy operation are important from an environmental point of view?

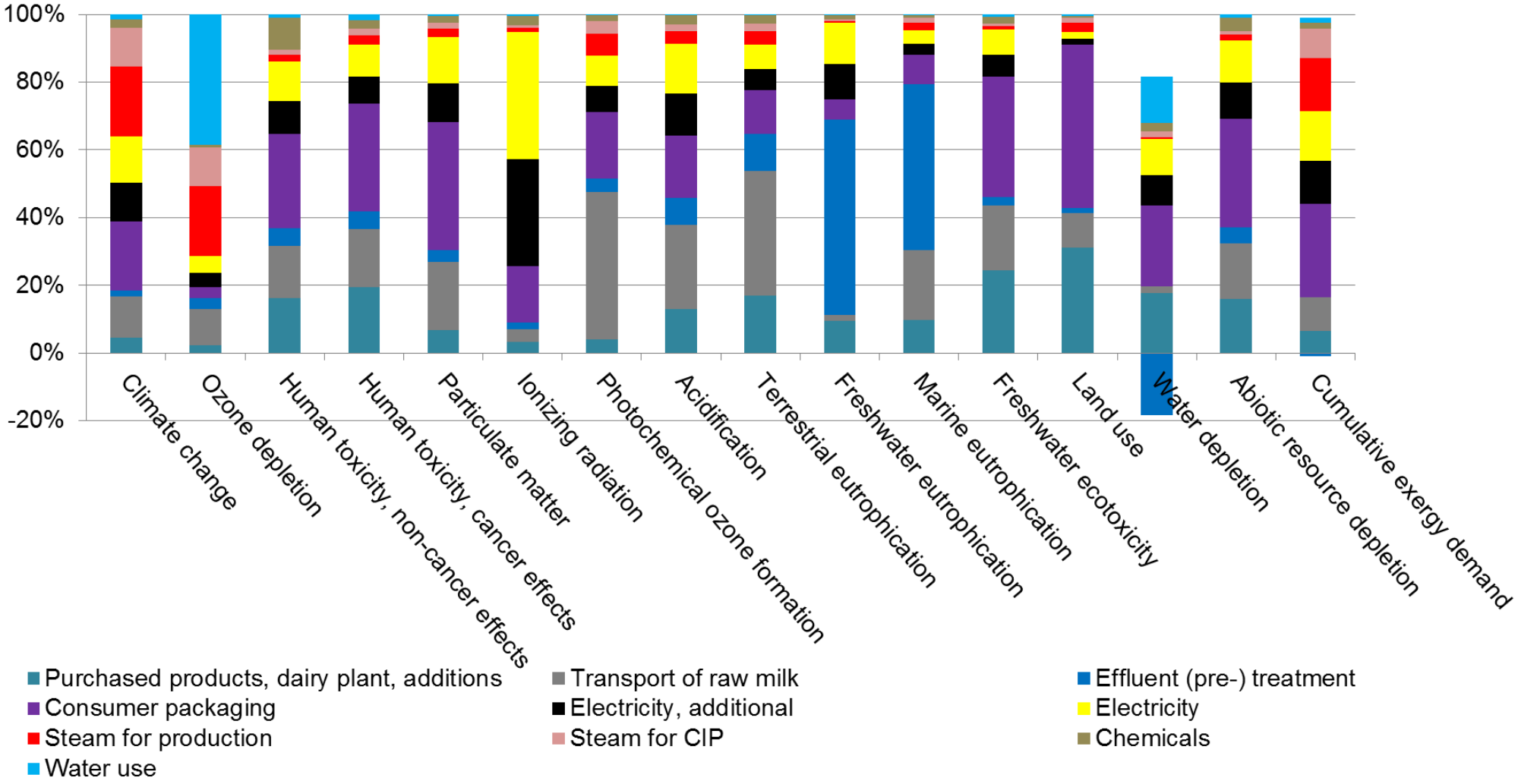
Scope A

- Impact Assessment Methods
  - 15 ILCD midpoint categories
  - Cumulative exergy demand
- Functional unit
  - A) one day of operation
- Scope: From cradle to dairy gate, incl. disposal of packaging
  - A) But **excluding** raw milk input

Methods A: Inputs groups for analysis

- Purchased products; dairy plant; additions
- Transport of raw milk
- Effluent (pre-)treatment
- Consumer packaging (production and disposal)
- Electricity
- Steam for production /CIP
- Chemicals used for CIP
- Water use and cooling (excl. electricity use)

Results A: Dairy operation



Interpretation A: Dairy operation

- High share in many categories
  - Transport of raw milk
  - Packaging (incl. disposal)
- High share for climate change and exergy
  - Heat, provided by natural gas boiler
- Low share
  - Chemicals for cleaning in place

➢ Remember that raw milk is excluded!

Goal B

B) How can energy, water and chemical use of a dairy be allocated to the dairy products?

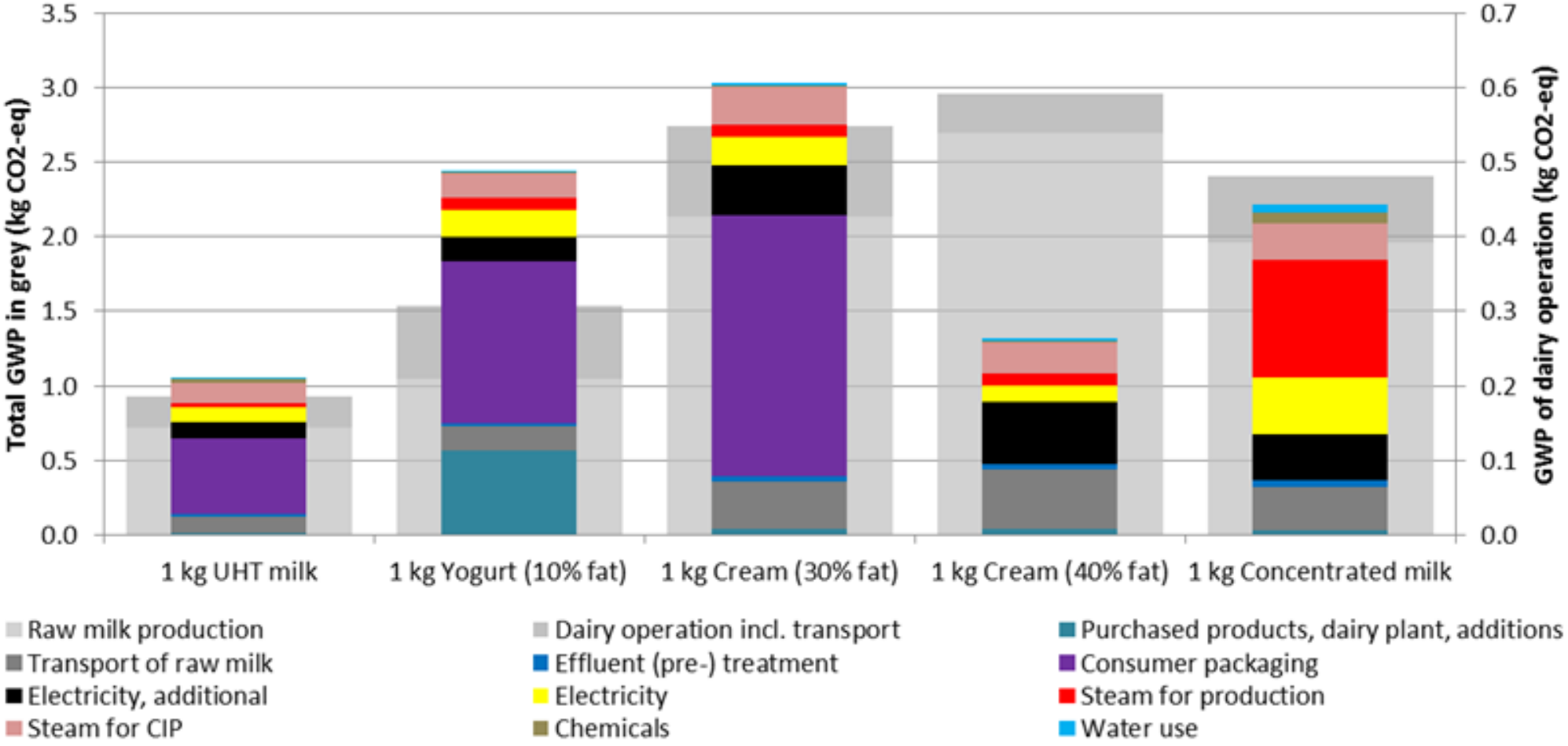
Scope B

- Impact Assessment Methods
  - Climate Change
  - Selected single inputs per kg of product
- Functional unit
  - B) 1kg of dairy product
- Scope: from cradle to dairy gate, incl. disposal of packaging
  - B) **Including** raw milk input

Methods B

- Climate Change
  - Same input groups as for A
  - Showing the impact of raw milk plus transport separately from the other inputs
- Selected single inputs per kg of product
  - For products yogurt, cream (40%) and UHT milk
  - Inputs according to the detailed LCA dairy model
  - Allocation of sum of inputs (3 products) of the LCA dairy model according to the method suggested by Feitz et al.

Analysis of products



Columns in the back: total GWP (left axis). Raw milk production: light grey, dairy operation: dark grey). The colored columns show the subdivision of the dairy operation in process stages (right axis).

- Raw milk input and impacts of processing differ between products

Interpretation B: Dairy products

- All products
  - Raw milk input and transport have the highest share
- Yogurt, cream (30%), UHT milk
  - Packaging has a high share (other products are unpacked)
- Concentrated milk
  - heat input has highest share

Results B: Allocation

b) Allocation of the LCA dairy model inputs (based on 3 products) according to Feitz et al. (2007)							
	Raw milk	*Water use*	*Elec-tricity*	*Themal energy*	*Alkaline cleaners*	*Acid cleaners*	*Waste water*
	kg	kg	MJ	MJ	g	g	l
Yogurt (0.2/3.4% fat)	1.2	2.5	1.0	0.9	4.5	0.745	2.535
Cream (40% fat)	3.6	1.3	0.2	0.3	4.5	0.745	1.358
UHT milk (3.7% fat)	1.1	1.3	0.4	0.5	4.5	0.745	1.358
c) Inputs according to the LCA dairy model							
	Raw milk	*Water use*	*Elec-tricity*	*Steam use*	*NaOH 50 %*	*HNO3 70 %*	*Waste water*
Yogurt (10% fat)	1.4	1.8	0.5	0.6	1.325	0.096	1.776
Cream (40% fat)	3.6	2.4	0.8	0.8	1.709	0.124	2.364
UHT milk (3.5% fat)	1.0	1.2	0.3	0.4	6.070	1.086	1.261

- Differences for chemicals and water

Interpretation B:

- Water, electricity and heat
  - More allocated to cream based on the LCA dairy model compared to suggestion of Feitz et al.
- Amount of chemicals
  - No differentiation given in Feitz et al.
  - LCA dairy model: highest for UHT milk, lower for cream, lowest for yogurt, based on detailed CIP model

Summary & Outlook

- A detailed dairy model helps for understanding impacts of different energy and water uses
- The allocation can be refined by the detailed model
- The new model seems to better allocate the CIP processes
- So far only few products thus more products need to be integrated in the model for covering the full range of dairies

Questions?

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Jungbluth N., Keller R., Doublet G., König A. and Eggenberger S. (2016) Report on life cycle assessment, economic assessment, potential employment effects and exergy-based analysis: Part I - LCA. Deliverable 7.3. SUSMILK - Re-design of the dairy industry for sustainable milk processing, Seventh Framework Programme: Project no. 613589. Funded by EC. Deliverable D7.3.

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