

MULTILEVEL ENVIRONMENTAL ASSESSMENT OF DAIRY PROCESSING INDUSTRY IN THE CONTEXT OF CIRCULAR ECONOMY



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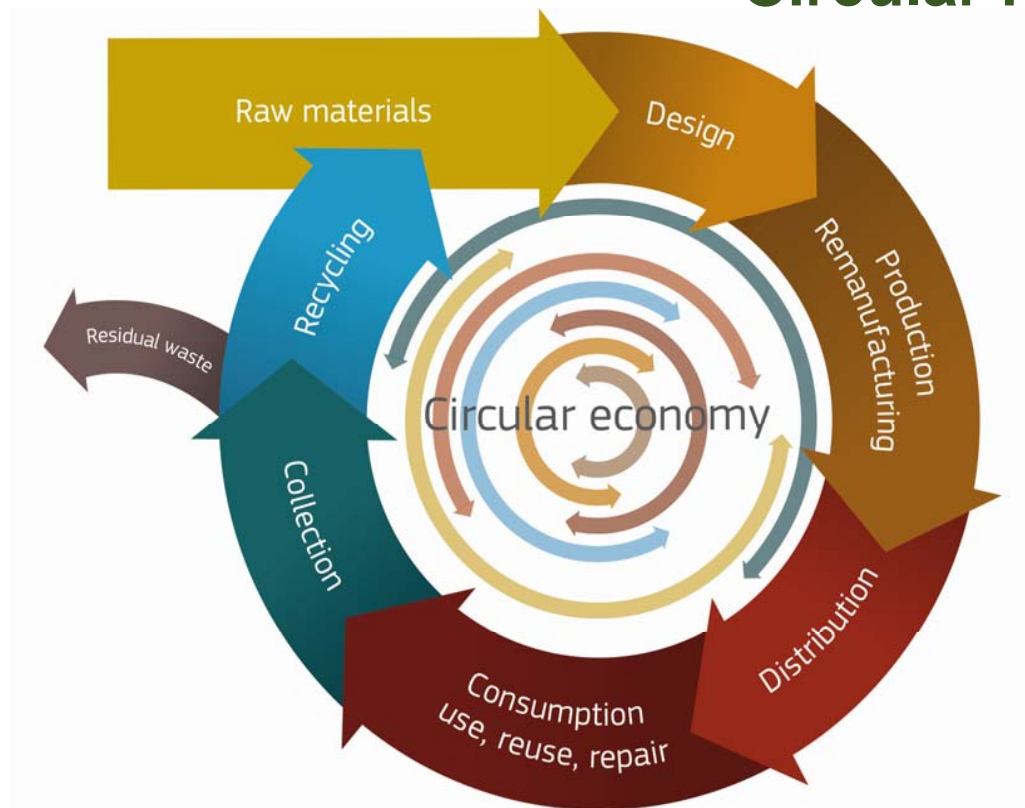


LCA within the circular economy concept

Linear model

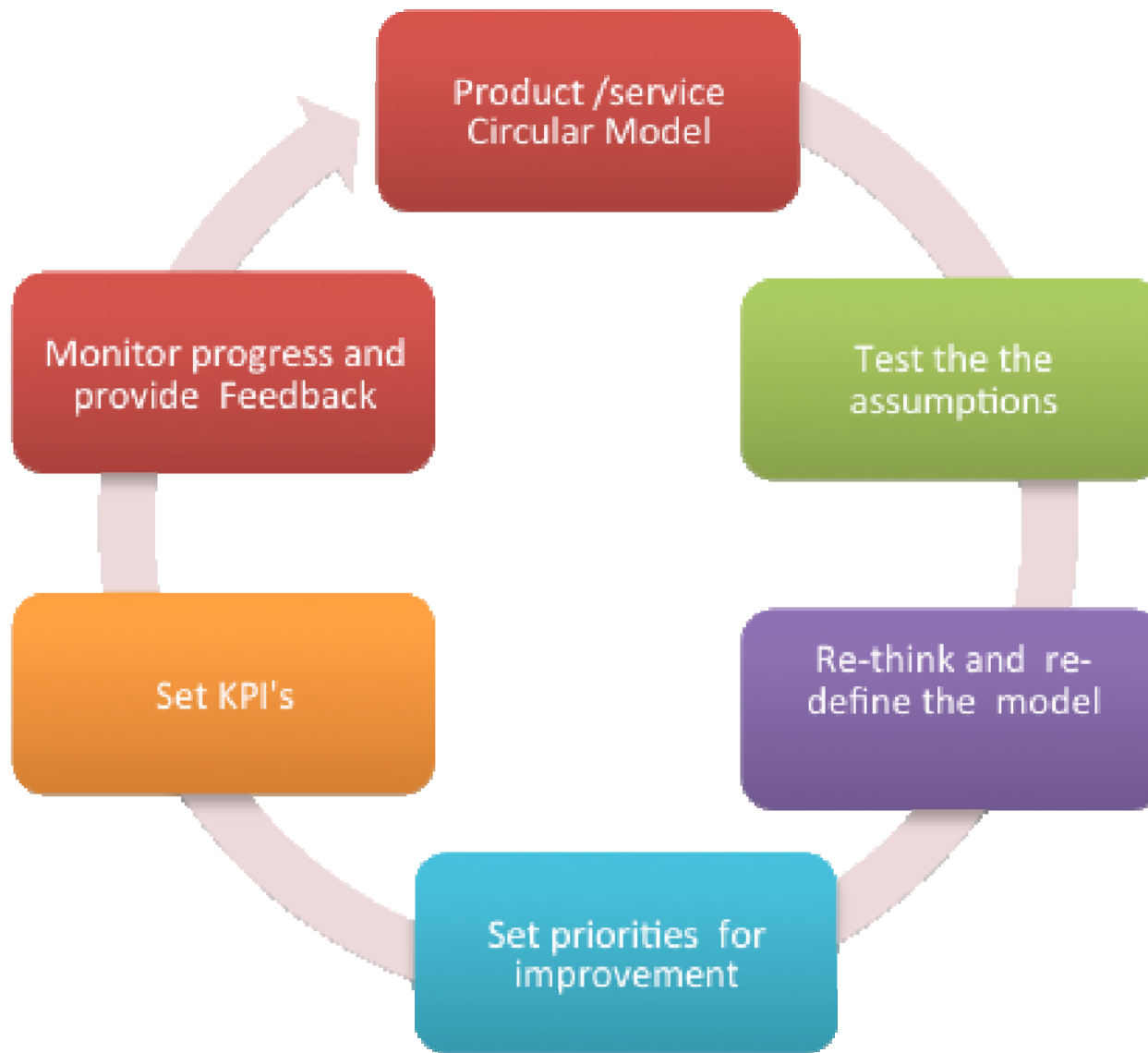


Circular model

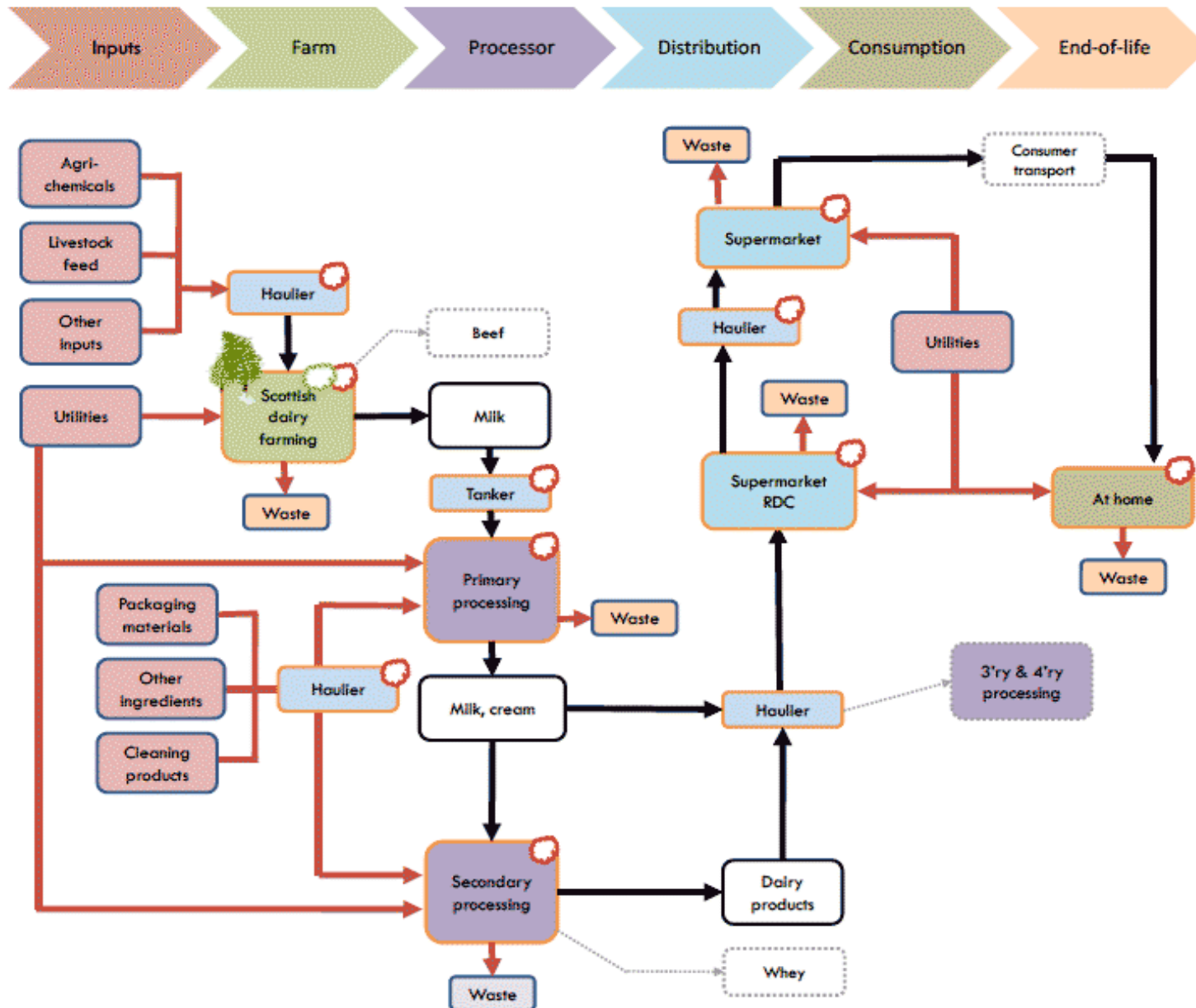


Source: European commission

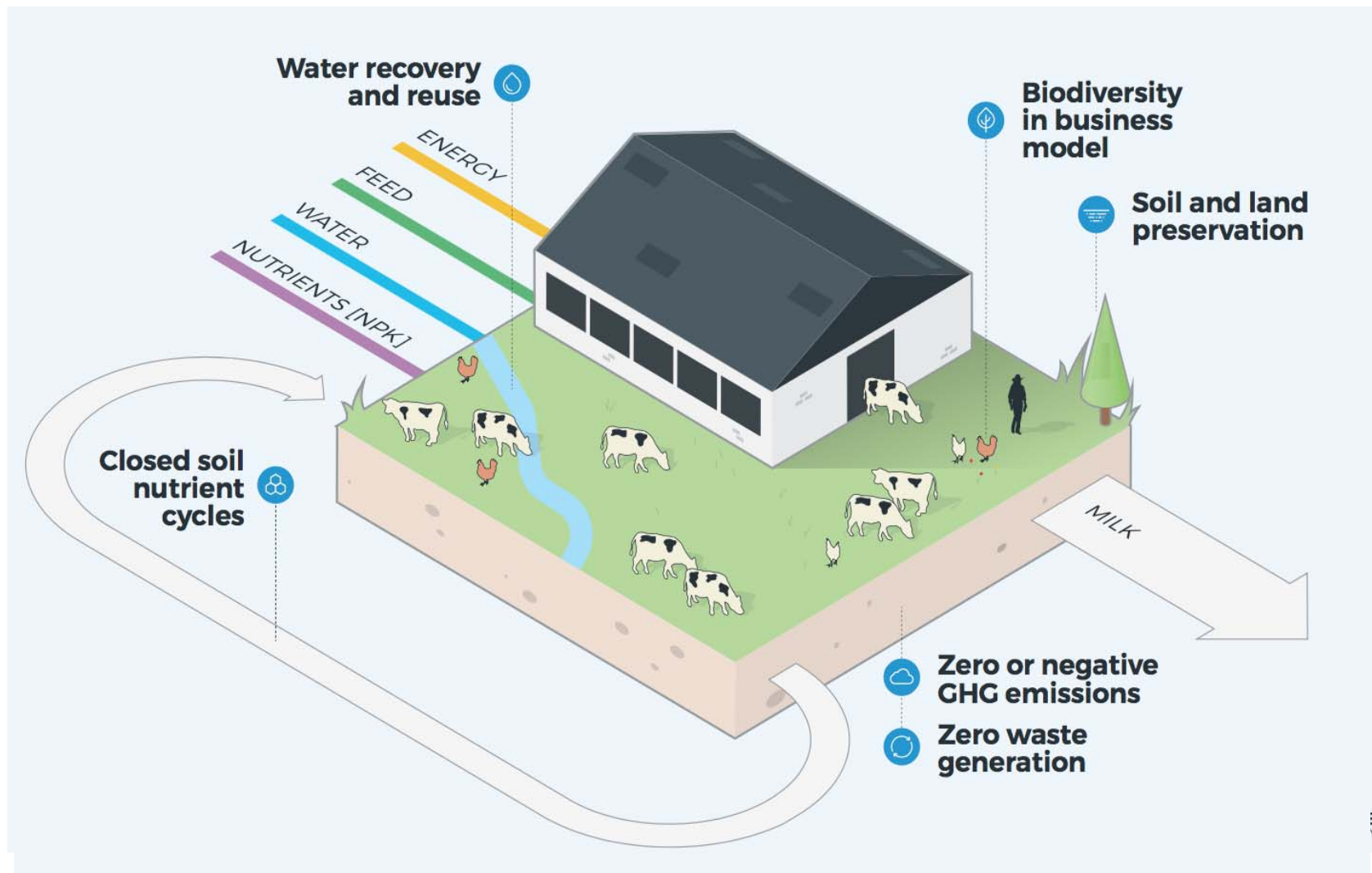
LCA within the circular economy concept



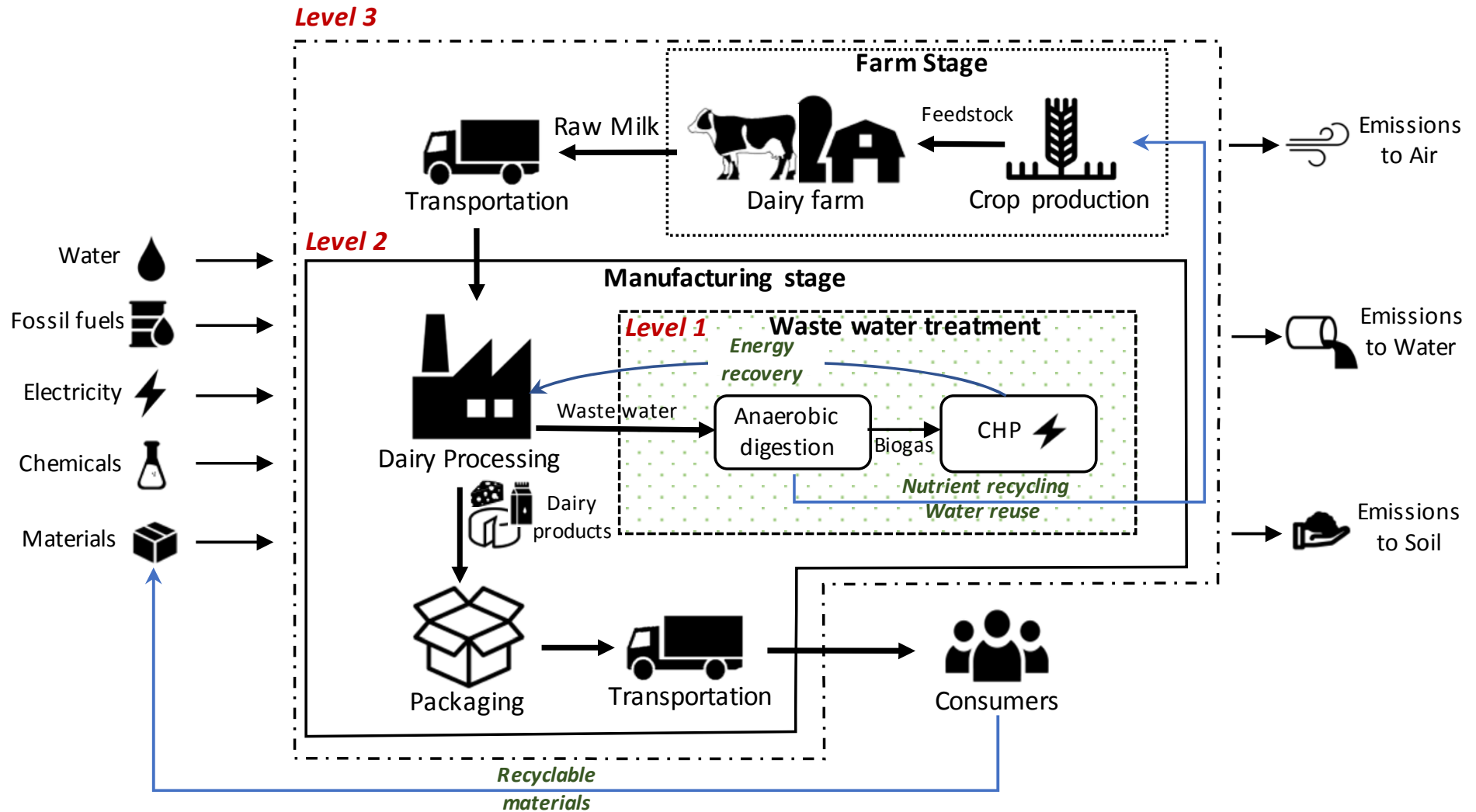
Dairy supply chain



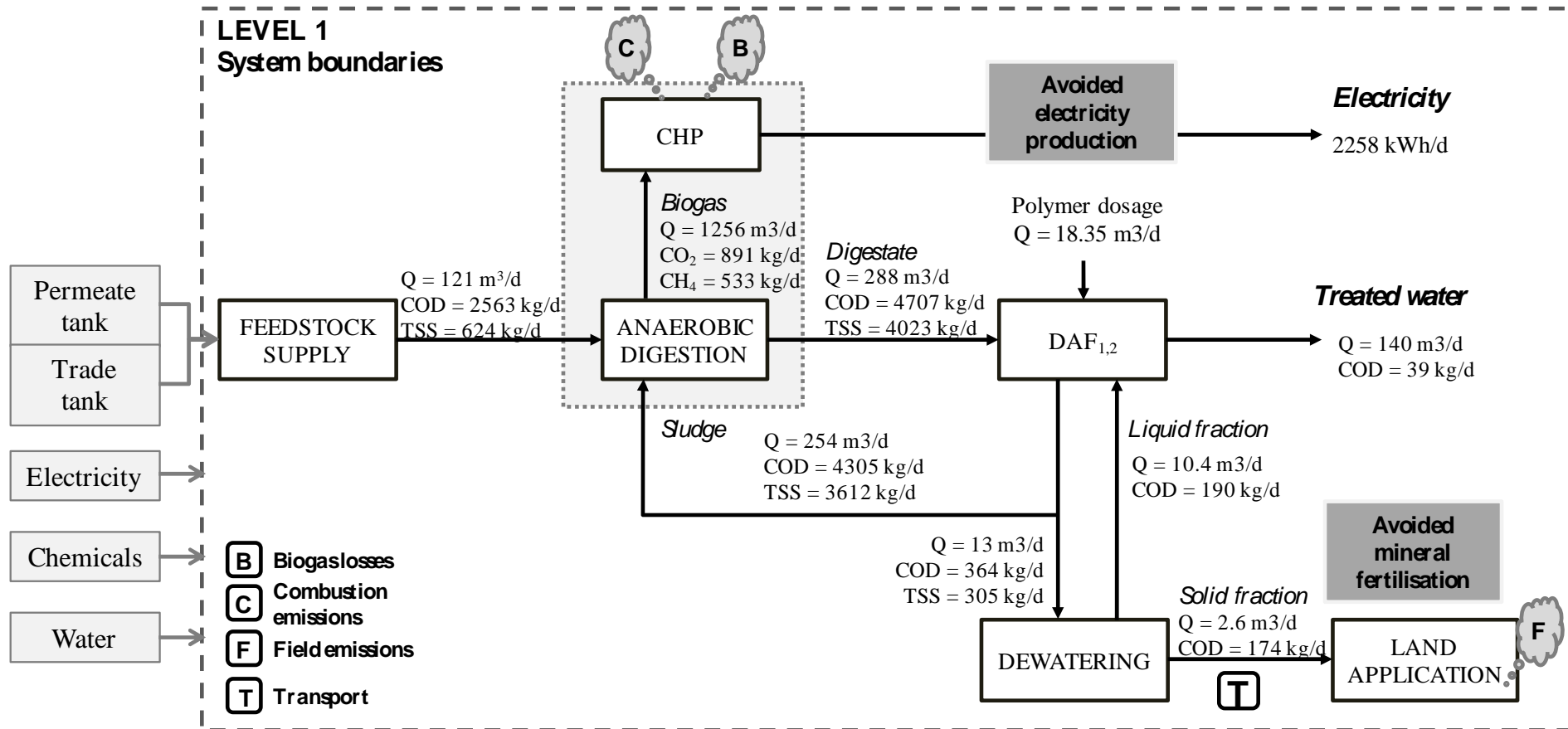
Circular dairy farms



A multilevel approach to define system boundaries



Treatment of dairy effluents – the role of AD



Life cycle inventory analysis

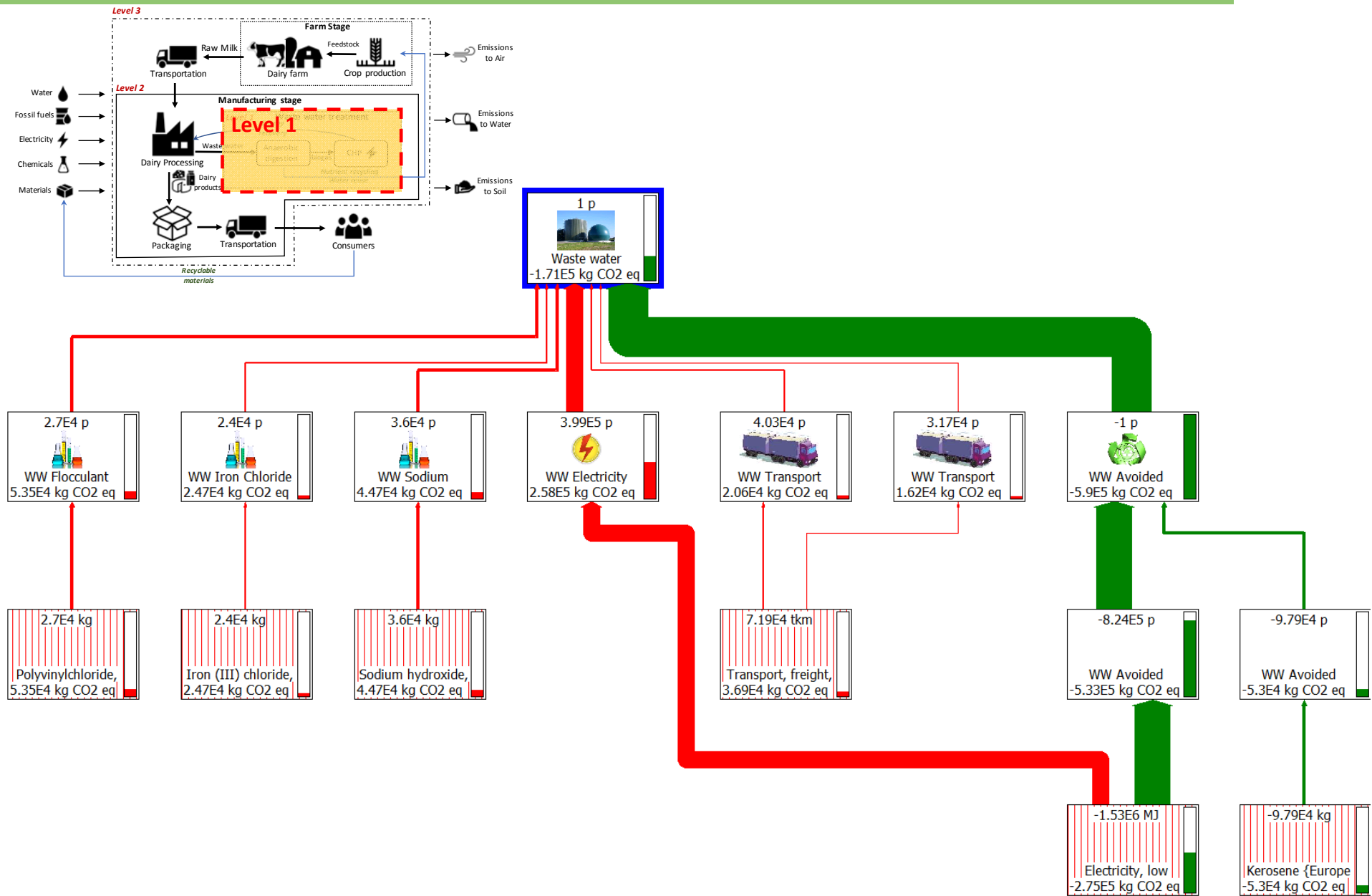
Inputs from technosphere	Amount	Unit
Raw milk	42,000,000	kg/year
Total Water Usage	12450	m3/year
<u>Chemical Usage</u>		
Dairy processing		
Disinfectant: mainly PAA	51125	kg/year
Detergent	4200	kg/year
Alkaline detergent: NaOH and KOH	152010	kg/year
Acid: nitric and phosphoric acid	8470	kg/year
Enzyme: protease, lipase	11210	kg/year
Wastewater treatment		
Flocculant (polyvinylchloride)	27000	kg/year
Calcium carbonate	1000	kg/year
Iron (III) chloride, without water,	24000	kg/year
Sodium Hydroxide	36000	kg/year
<u>Energy use</u>		
Dairy processing		
Fuel (Kerosene/light oil)	450934	kg/year
Electricity consumption	3687989	kwh/year
Wastewater treatment		
Electricity consumption	398652	kwh/year
<u>Packaging materials</u>		
Card Sleeve	18,942	kg/year
Cardboard Divider	2,200	kg/year
Cardboard Outer	15,330	kg/year
Paper Label	36,546	kg/year
Plastic Bucket	342,142	kg/year
Plastic Carton	3,978	kg/year
Plastic Film	12,860	kg/year
Plastic HDPE(2) Bottle	28,188	kg/year
Plastic HDPE(4) Lid	2,619	kg/year
Plastic label	643	kg/year
Plastic Lid	107,350	kg/year
Plastic Liner	22,330	kg/year
Plastic Pot	9,156	kg/year

Transportation

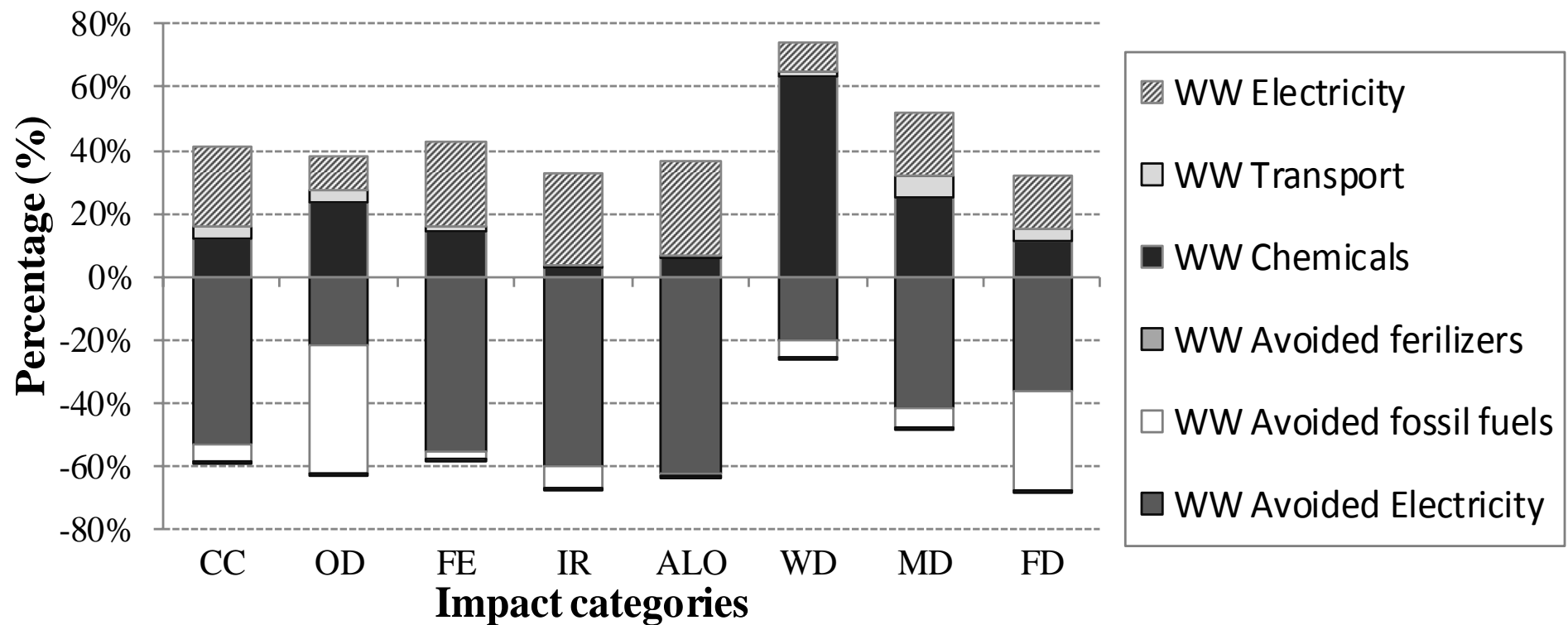
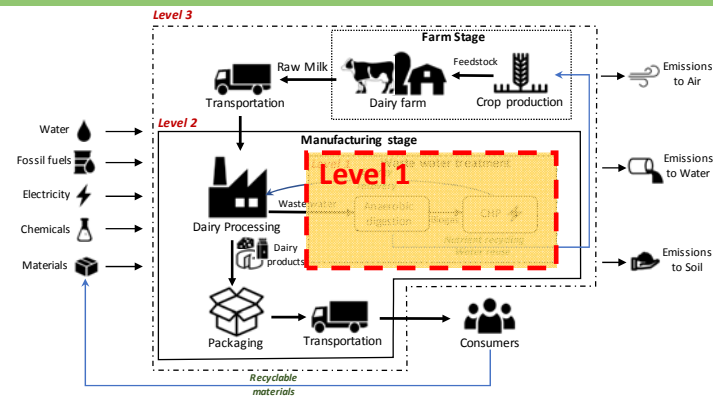
Distribution of products	7302050	t-km
Average Distance to main distribution points	310	km
Total weight of generated products	23555	t
Chemical/ingredients inputs	81725	t-km
Average distance from providers	360	km
Packaging materials	251755	t-km
Average distance from providers	418	km
Raw milk input	840000	t-km
Average distance from providers	20	km
Waste disposal	40250	t-km
Average distance to landfill	50	km

Outputs to technosphere	Amount	Unit
<u>Avoided energy production</u>		
AD Electricity Generation from CHP	824039	kwh/year
Avoided fertiliser production		
Generated sludge from anaerobic digestion	805000	kg/year
N fertiliser	283	kg/year
P fertiliser	69	kg/year
Waste		
Wastewater	80346	m3/year
Packaging waste	58.4	t

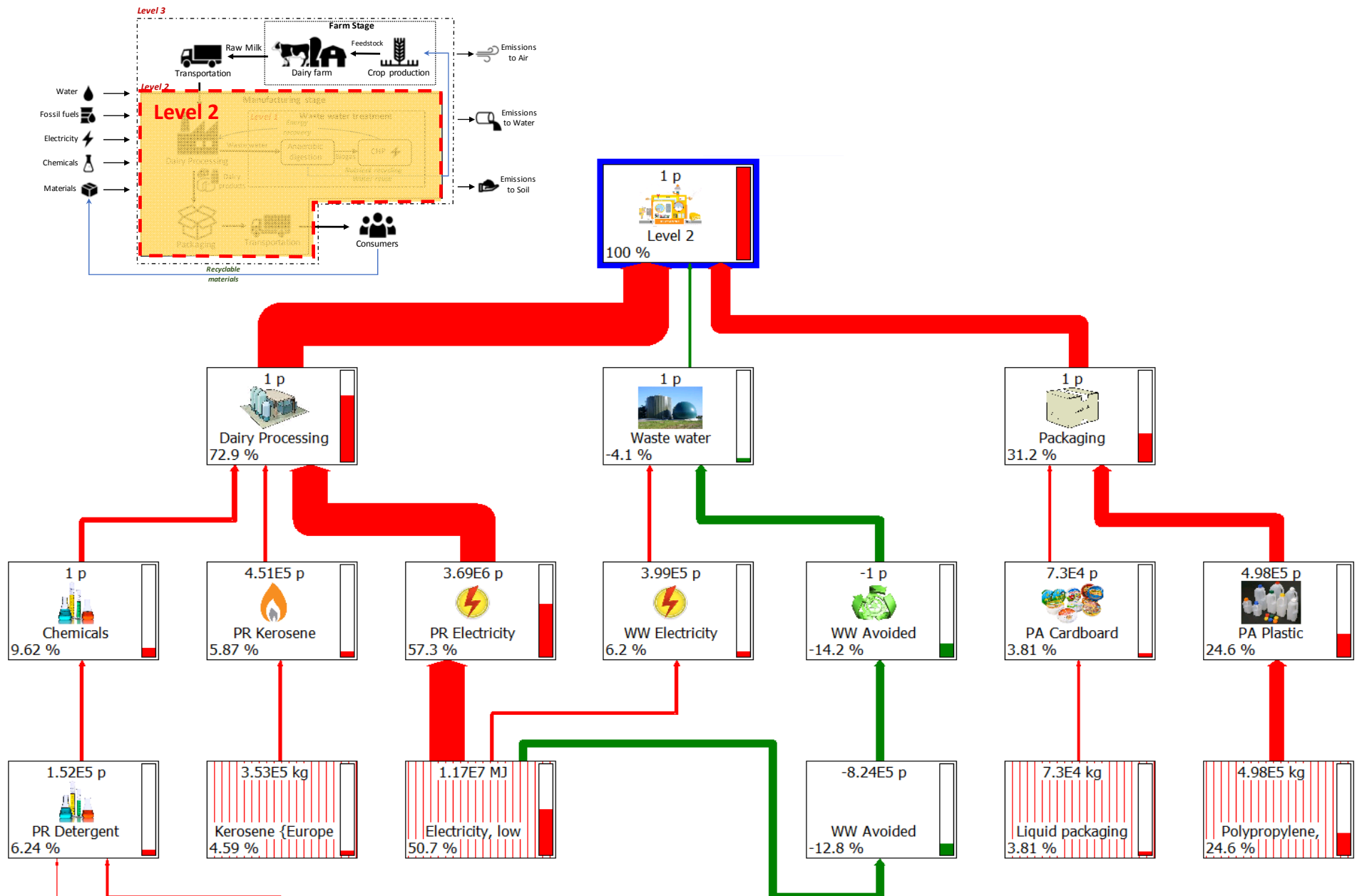
Environmental impact assessment - AD (Level 1)



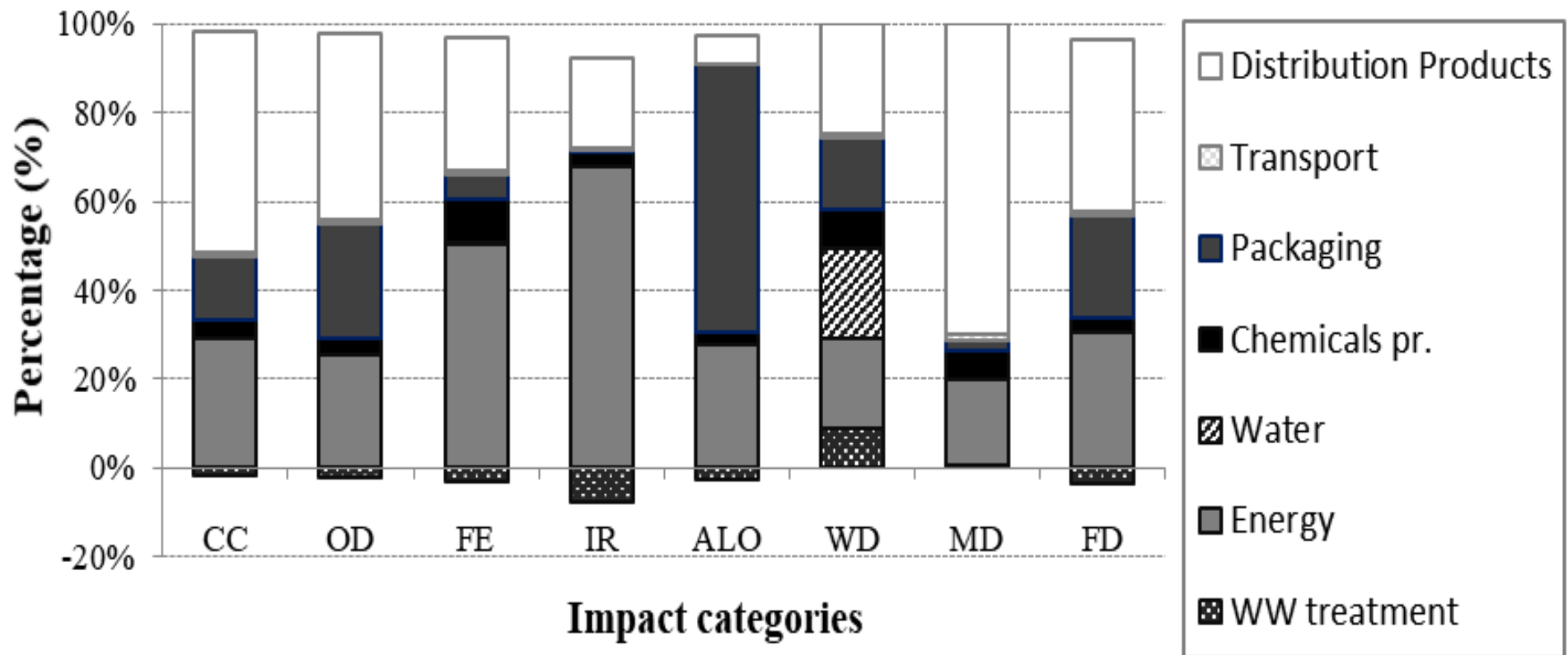
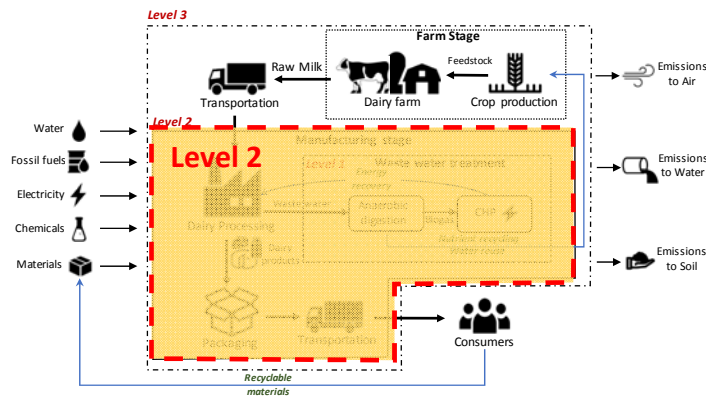
Environmental impact assessment - AD (Level 1)



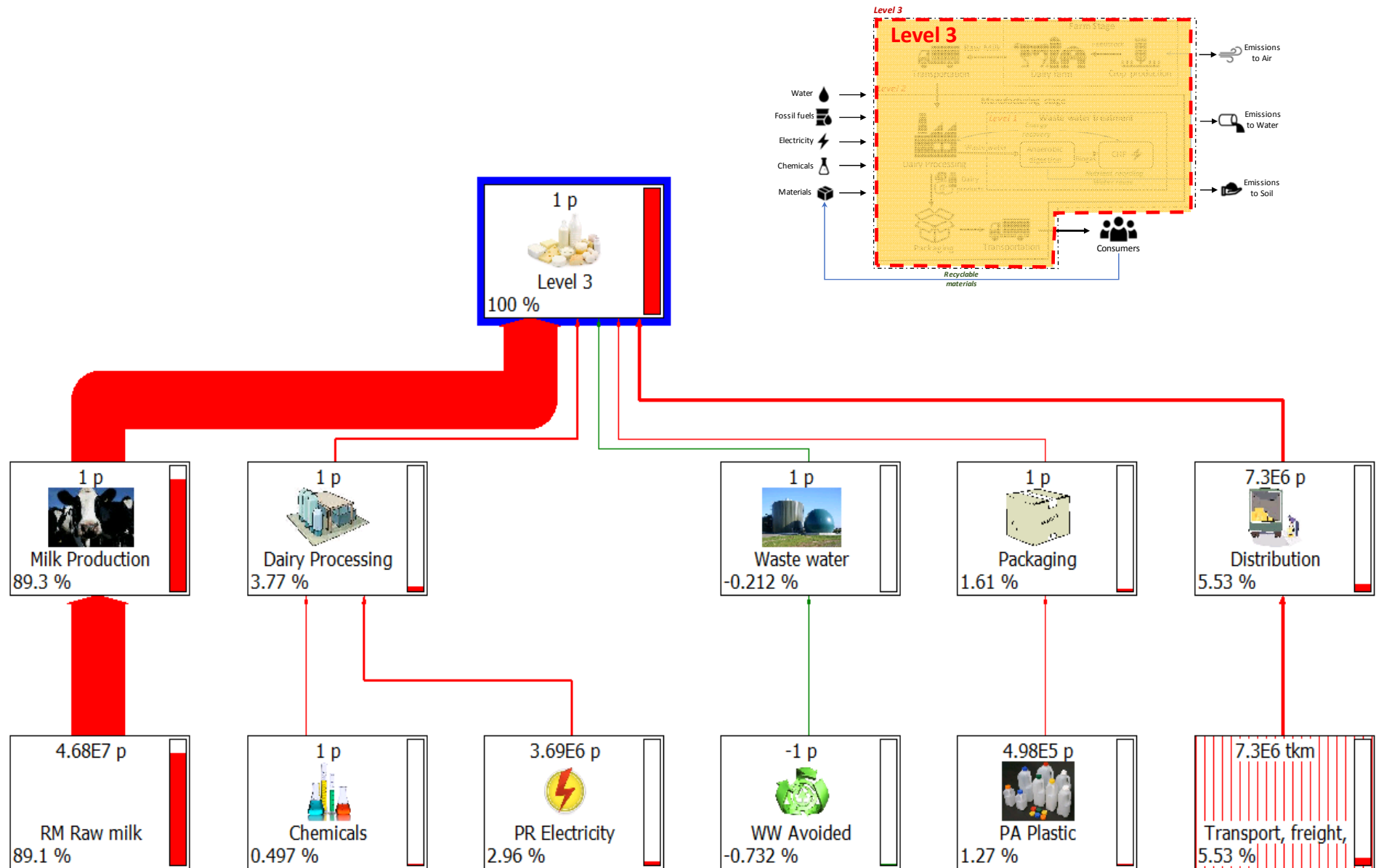
Dairy processing facility (Level 2)



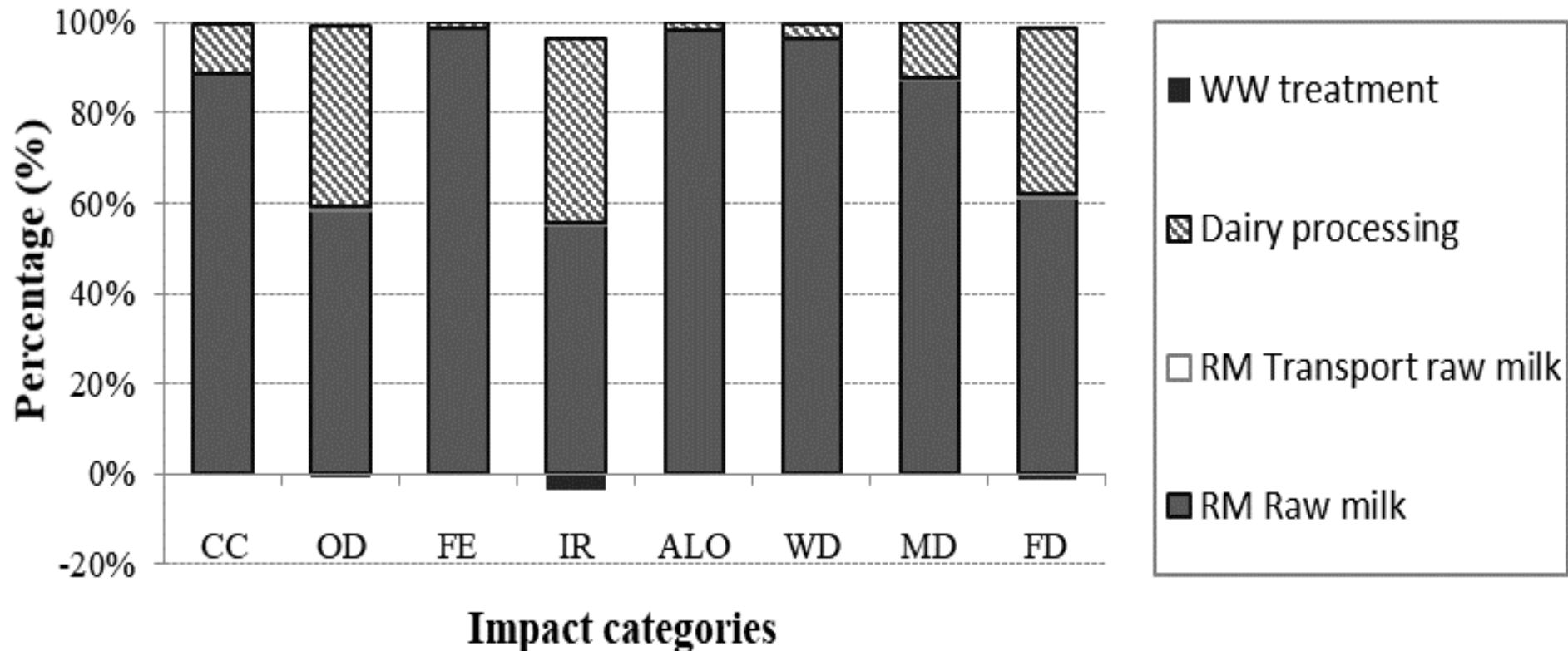
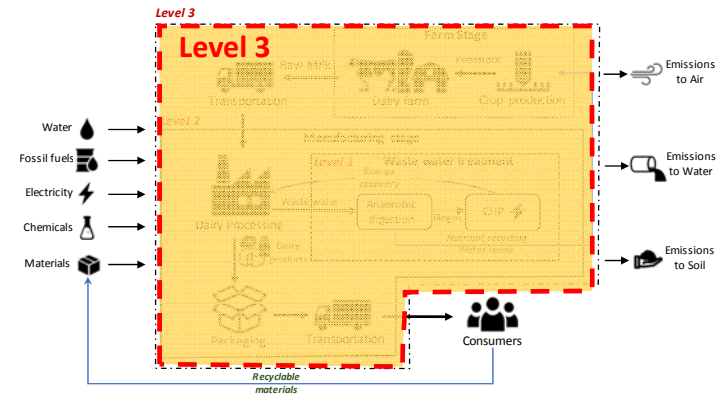
Dairy processing facility (Level 2)



The entire dairy supply chain (Level 3)



The entire dairy supply chain (Level 3)



Conclusions

- The **circular economy concept** should be complemented with **LCA** in order to assess **the net environmental impact** of the applied solutions and provide **KPIs** for improvement
- The **multilevel system boundaries approach** enabled the identification of the **environmental priority areas** for each sub-system and provided insight on the interactions between materials, energy and water flows.
- The **multilevel environmental analysis** can facilitate decision making for the implementation of sustainability measures and integrated management technologies

Thank you for your attention!
