Environmental impacts of food production and consumption

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1mi1 Expert talk series
Online presentation of applying LCA in policy making
12.5.2016

Overview of themes

- ESU-services Ltd.
- Impacts and reduction potentials for food consumption
- ESU-database
- LCA of chocolate
- Life cycle management for canteens
- LCA tool for SME's
- Food losses in LCA

ESU-services Ltd.

- Founded in 1998 as an ETHZ spin-off
- 3 co-workers
- Long time experience since 1994 with life cycle assessment (LCA)
- Clients from industry, NGO, administration, universities

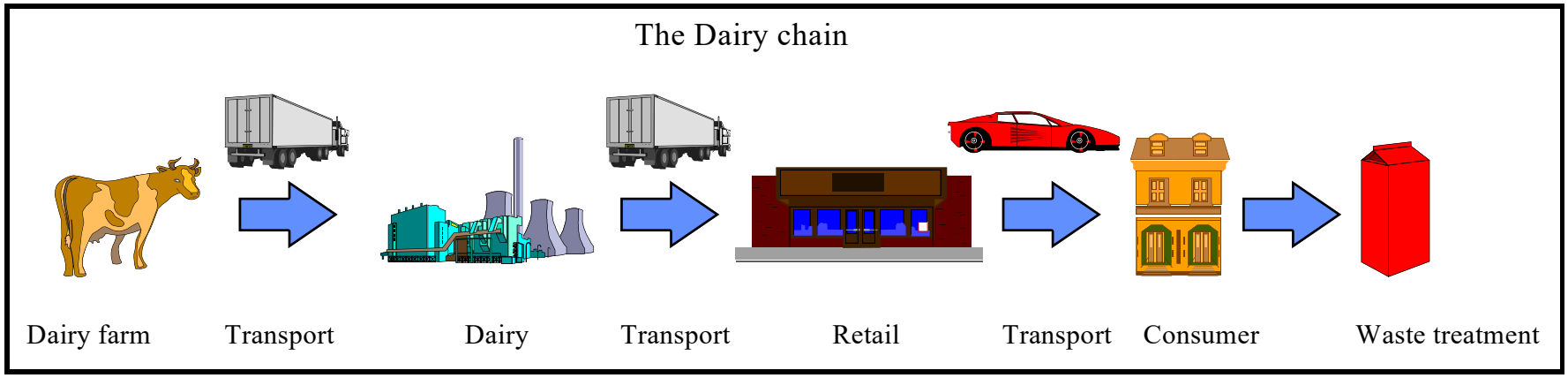
Our services

- Full-scale Life Cycle Assessments (LCA)
- Tiered LCAs
- LCI data acquisition and management (data-on-demand)
- LCA project management
- Ecolabelling concepts
- Literature surveys
- Critical peer reviews
- LCA training & coaching
- Regional SimaPro Centre (LCA software)

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 of Products



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- Cradle to grave
- Assessment of emission to air, water and soil as well as resources (water, energy, land)
- International standardisation ISO 14040 ff
- No absolute judgment nor accounting for social and economic aspects

Which Life cycle impact assessment

Carbon Footprint, CED:

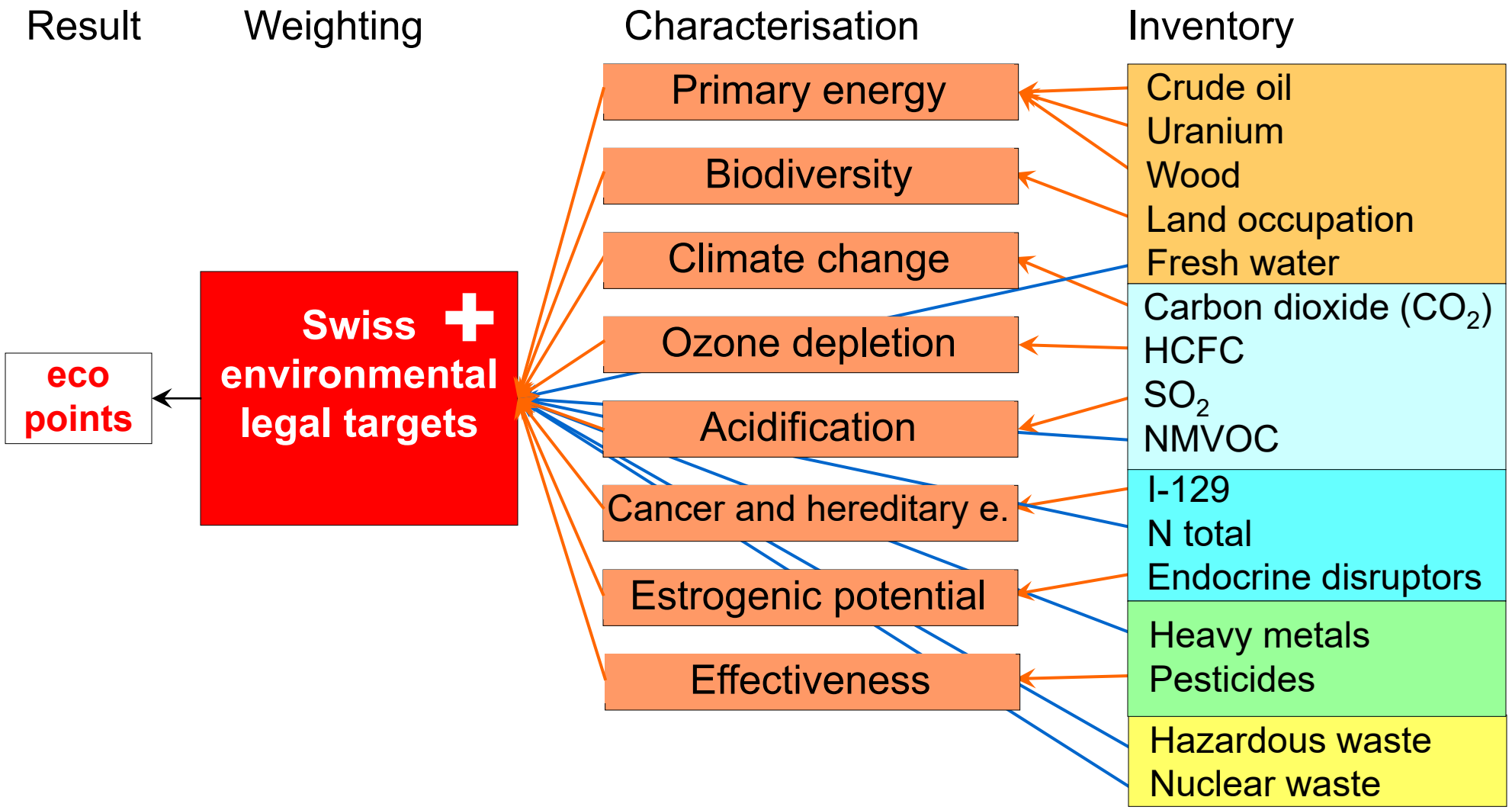
Ecological footprint:

Ecological scarcity: Comprehensive, reflects Swiss policy targets, used for assessment of products, companies and for the whole economy

		One environmental issue		Several issues	
	LCIA method:	CED	Carbon footprint	Ecological footprint	Ecological scarcity 2006
	Impact category				
Resources	Energy,non-renew able	√	∅	∅	√
	Energy, renew able	∅	∅	∅	√
	Ore and minerals	∅	∅	∅	√
	Water	∅	∅	∅	√
	Biotic resources	∅	∅	∅	∅
	Land occupation	∅	∅	√	√
	Land-transformation	∅	∅	∅	∅
Emissions	Only CO_2	∅	∅	√	∅
	Climate change incl. CO_2	∅	√	∅	√
	Ozone depletion	∅	∅	∅	√
	Human toxicity	∅	∅	∅	√
	Particulate matter formation	∅	∅	∅	√
	Photochemical ozone formation	∅	∅	∅	√
	Ecotoxicity	∅	∅	∅	√
	Acidification	∅	∅	∅	√
	Eutrophication	∅	∅	∅	√
	Odours	∅	∅	∅	∅
	Noise	∅	∅	∅	∅
	Ionising radiation	∅	∅	∅	√
	Endocrine disruptors	∅	∅	∅	√
Others	Accidents	∅	∅	∅	∅
	Wastes	∅	∅	∅	√
	Littering	∅	∅	∅	∅
	Salinisation	∅	∅	∅	∅
	Erosion	∅	∅	∅	∅

- The three indicators CED, carbon footprint and ecological scarcity are calculated

Ecological Scarcity 2006



Environmental impacts of consumption patterns in Switzerland and reduction potentials

Different projects finances by
WWF Switzerland
Energieforschung Zurich – ewz-electricity supply Zurich
Swiss Federal Office for the Environment, FOEN
Here we present our personal summary

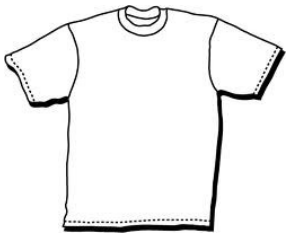
Key questions

- What are the total environmental impacts of consumption and how can they be allocated to consumption areas?
- What are the most important aspects within consumption areas?
- Which options exist for the reduction of environmental impacts due to consumption?
- Difficulties and rebound effects for implementation are not considered

Environmental impacts of lifestyles

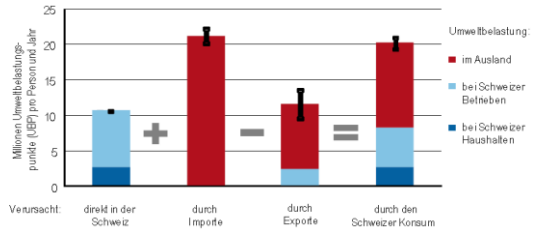
Public

Private

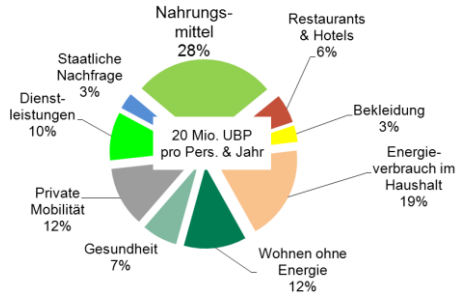


Main stages for the calculation

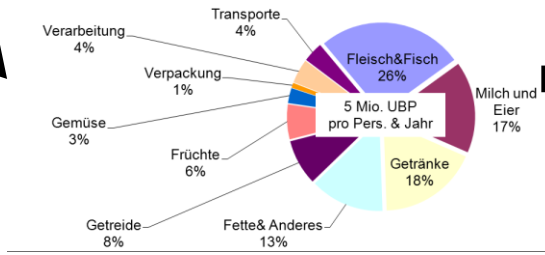
1. Total impacts CH



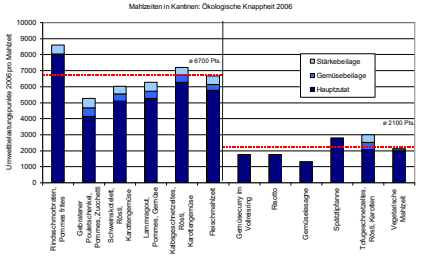
2. Share of consumption areas



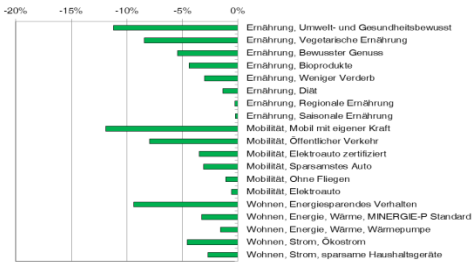
3. Further analysis



4. Reduction potentials



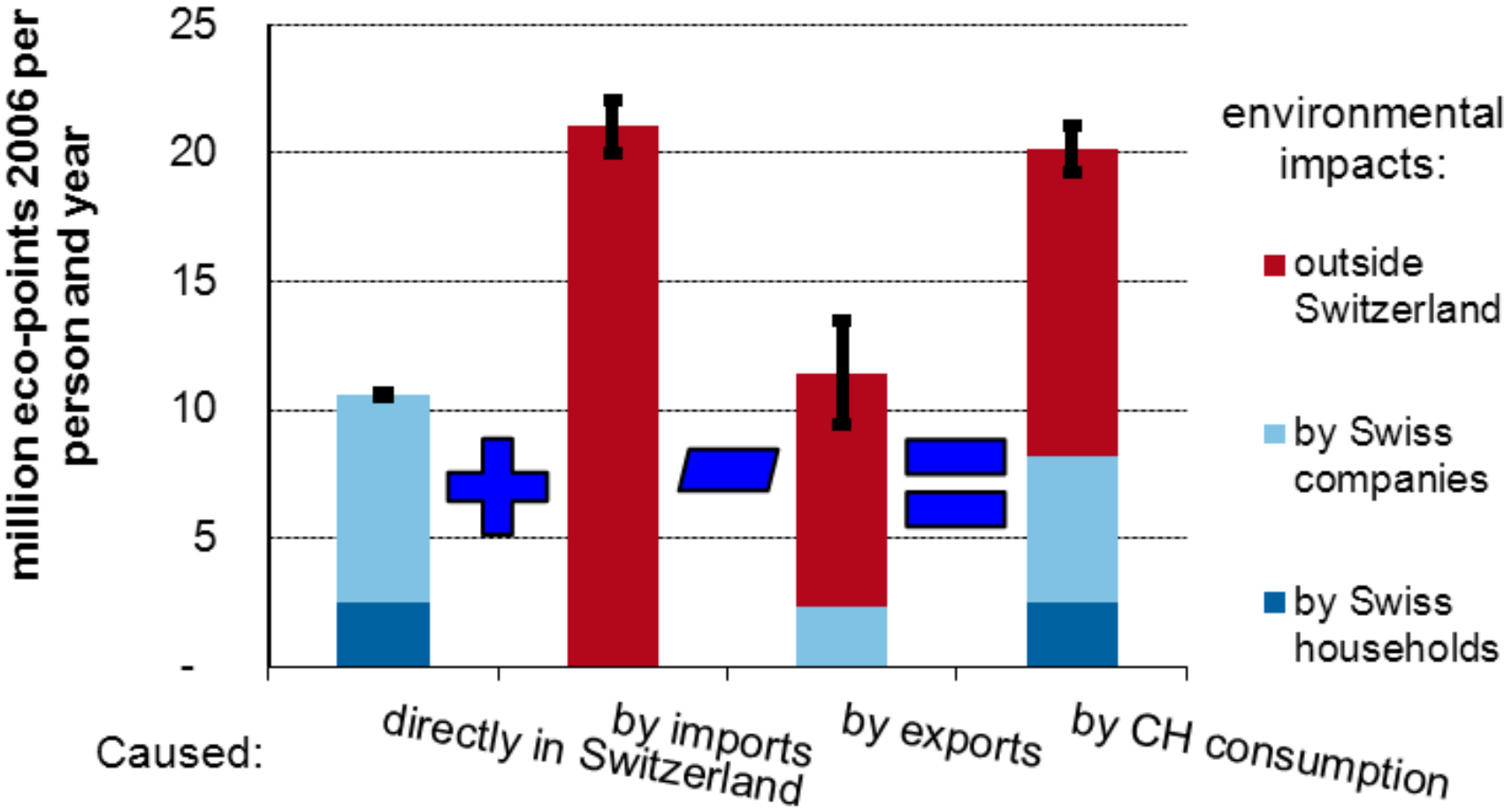
5. Total potentials



TOTAL IMPACTS IN SWITZERLAND

MEAN FIGURES OF SWISS EE-IOA AND SIMPLIFIED "LCA&TRADE" APPROACH

Total balance of Swiss impacts



- Imports cause 60% of environmental impacts due to Swiss consumption

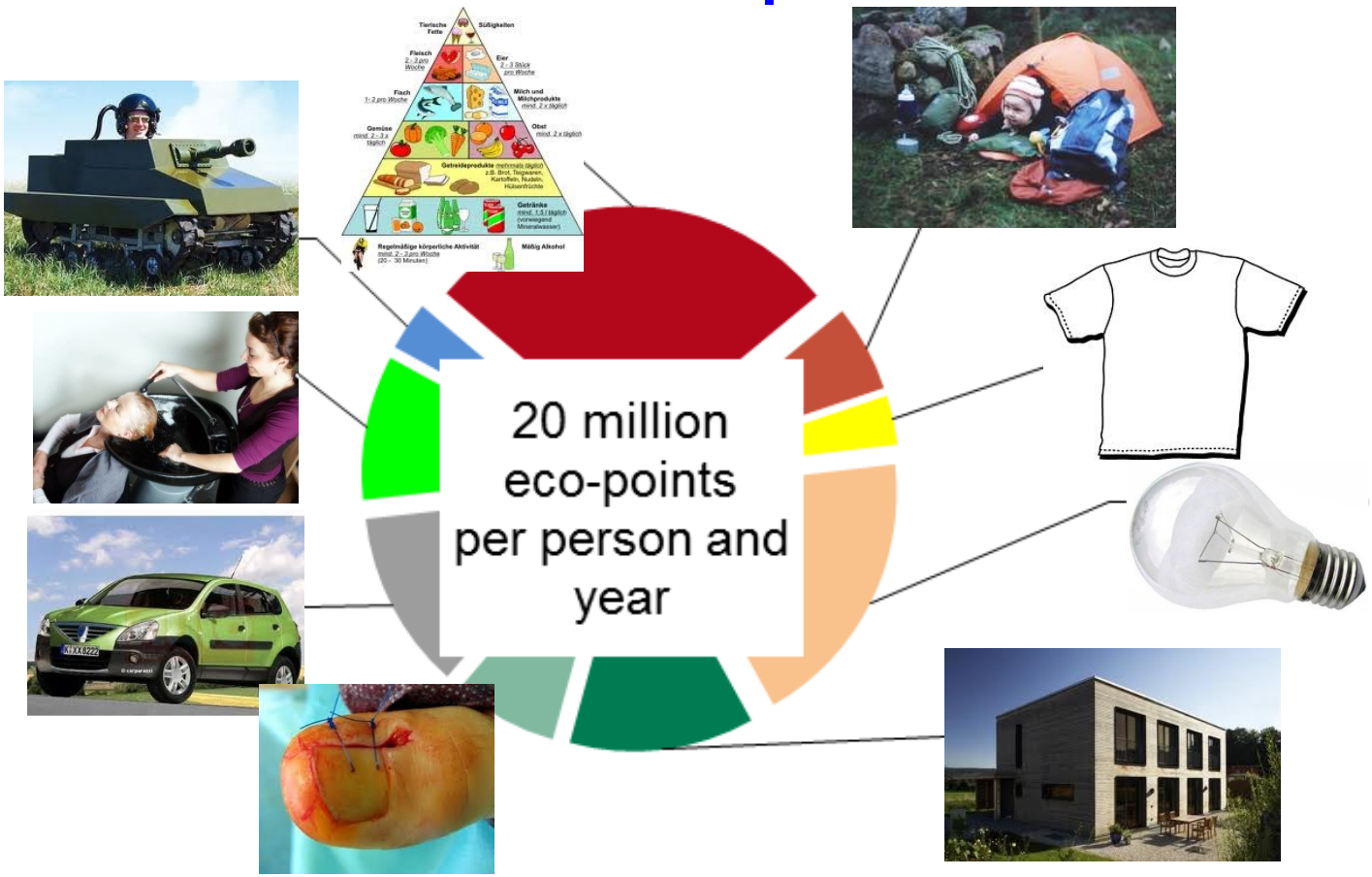
Key figures per capita and year for Switzerland

	Consumption perspective	2000-Watt current situation
Tonnes CO_2-eq	12.8	8.6
Watt	8’250	6’300
eco-points	20 Million	~ 8.5 Million

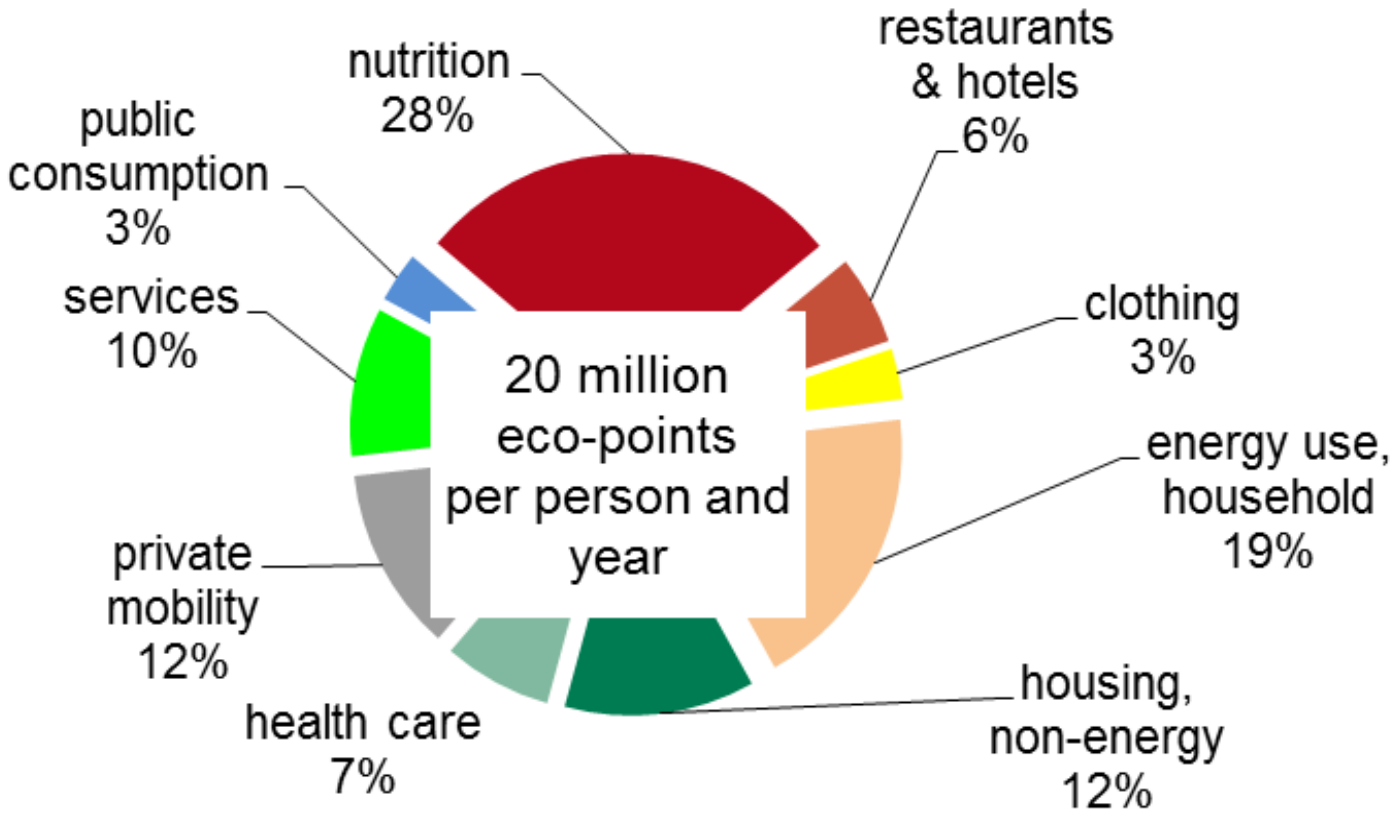
- Considerable differences because of different system boundaries

SHARE OF CONSUMPTION AREAS
CALCULATION WITH SWISS EE-IOA

Share of consumption areas

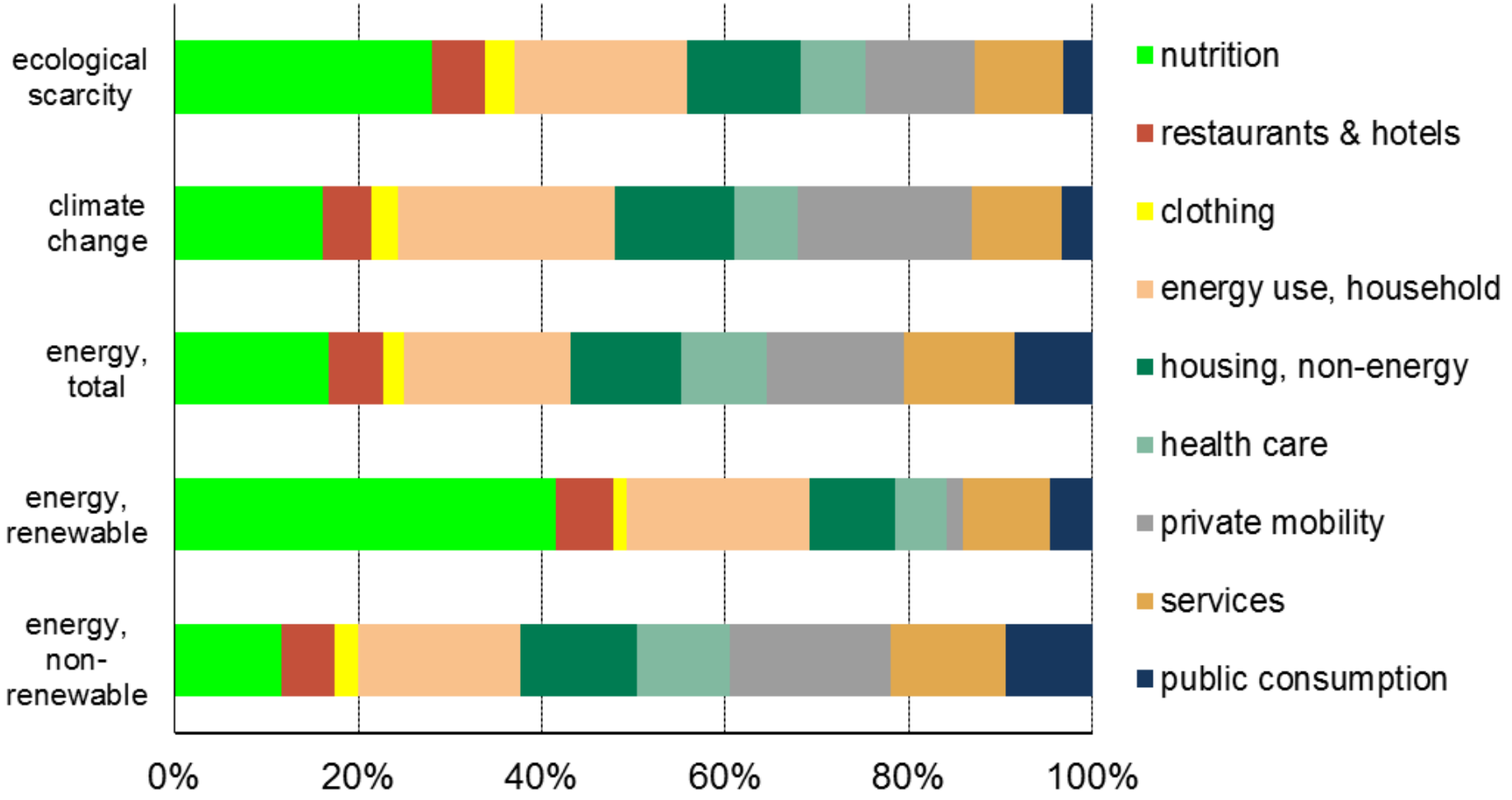


Share of consumption areas



- Nutrition is the most important consumption area with 28%
- 60% of environmental impacts in nutrition, energy use and mobility

Different indicators and share of final consumption areas



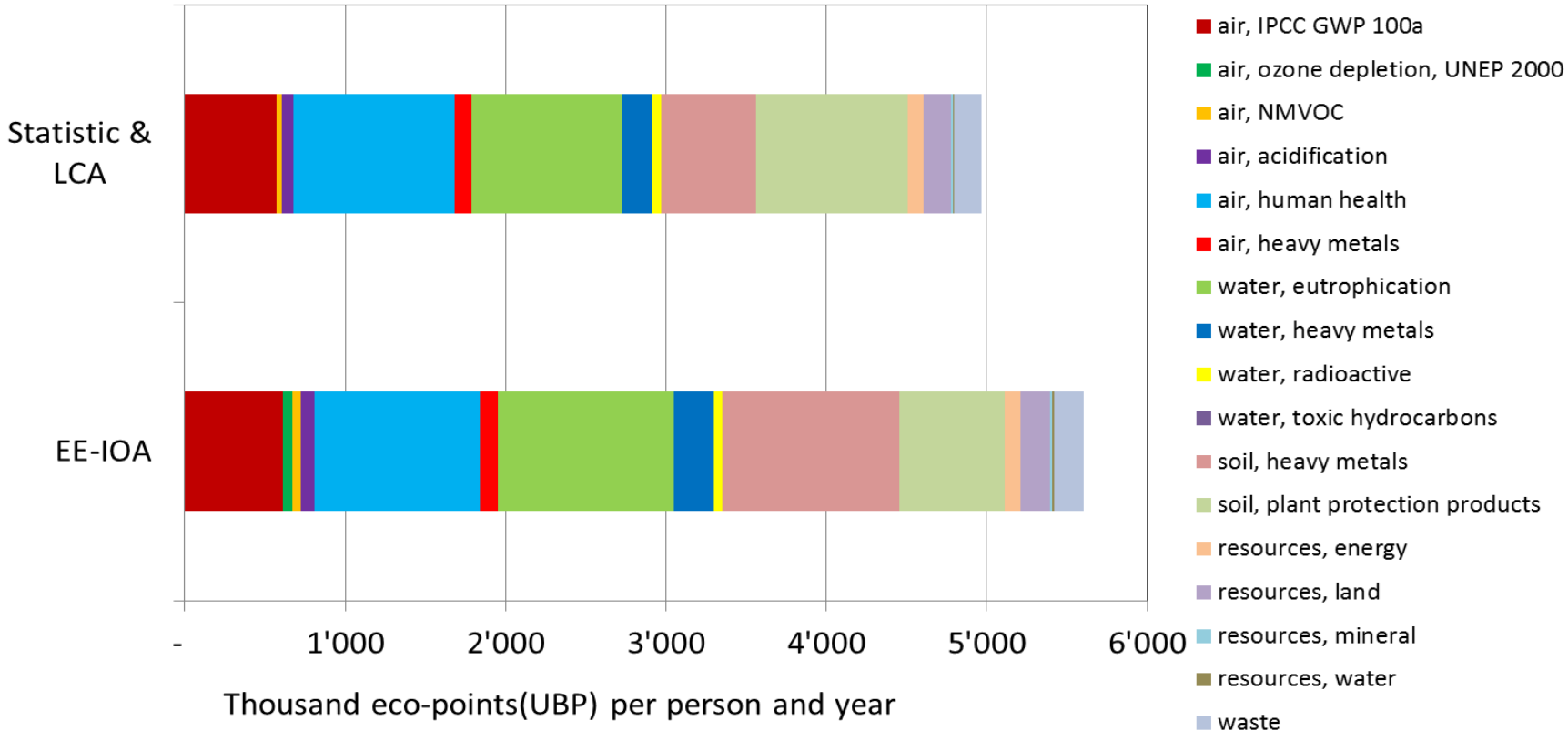
- Energy and GHG indicators underestimate the contribution of nutrition

FURTHER ANALYSIS OF CONSUMPTION AREAS

TOP-DOWN AND BOTTOM-UP

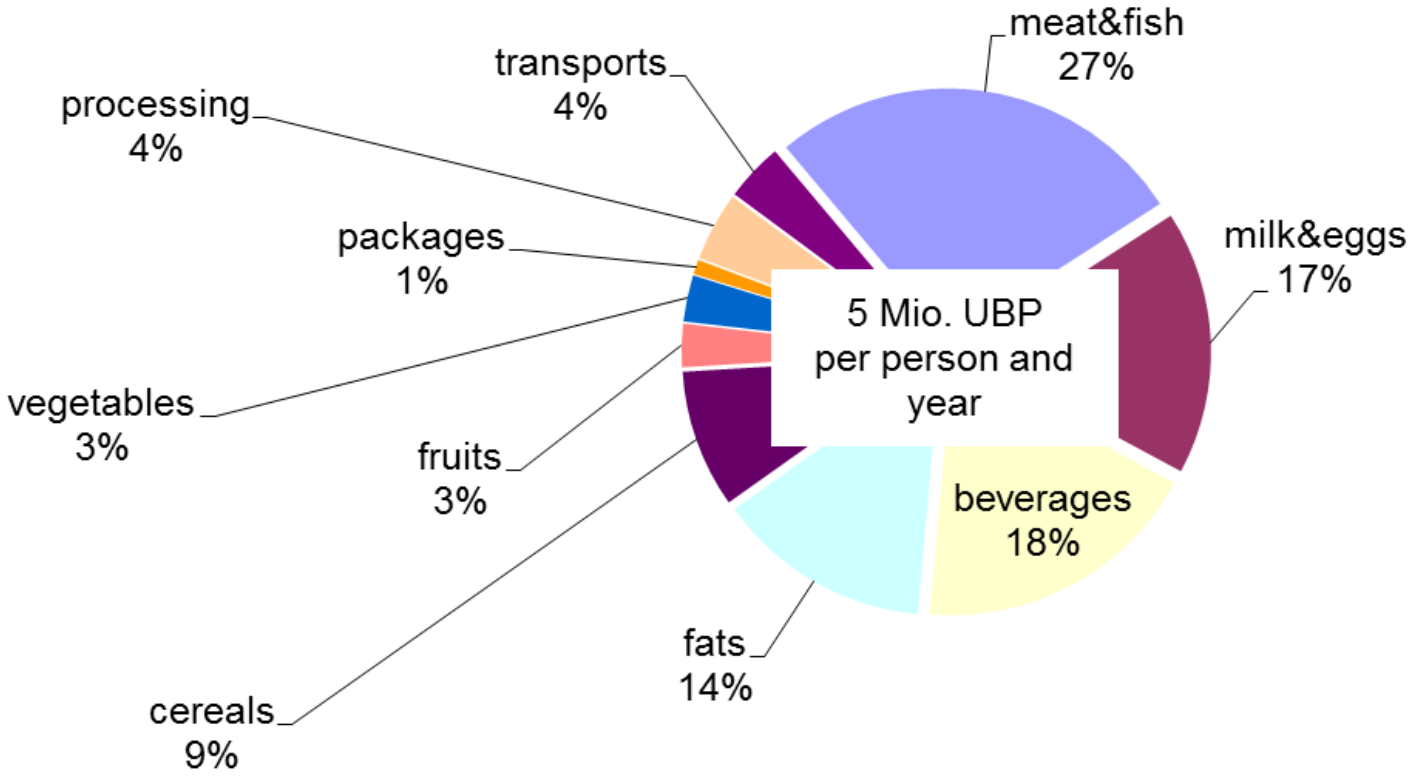
ASSESSMENT WITH LCA AND COMPARISON WITH EE-IOA

Environmental impacts of food purchases



- Top-Down and bottom-up come to comparable results
- Further analysis of consumption areas based on LCA and statistics

Product groups within nutrition



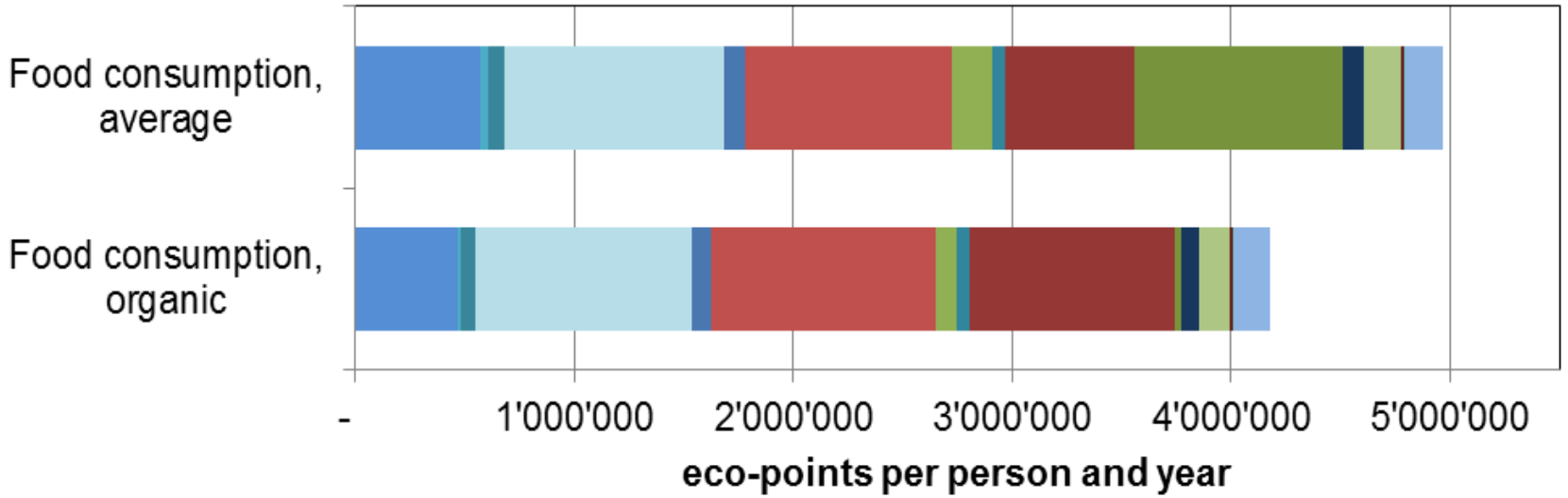
- Meat and animal products cause 44% of total impacts
- Wine, coffee and beer are important for beverages

REDUCTION POTENTIALS

ANALYSIS OF SINGLE CHANGES IN LIFESTYLES

EXAMPLE FOR BUYING ORGANIC FOOD PRODUCTS

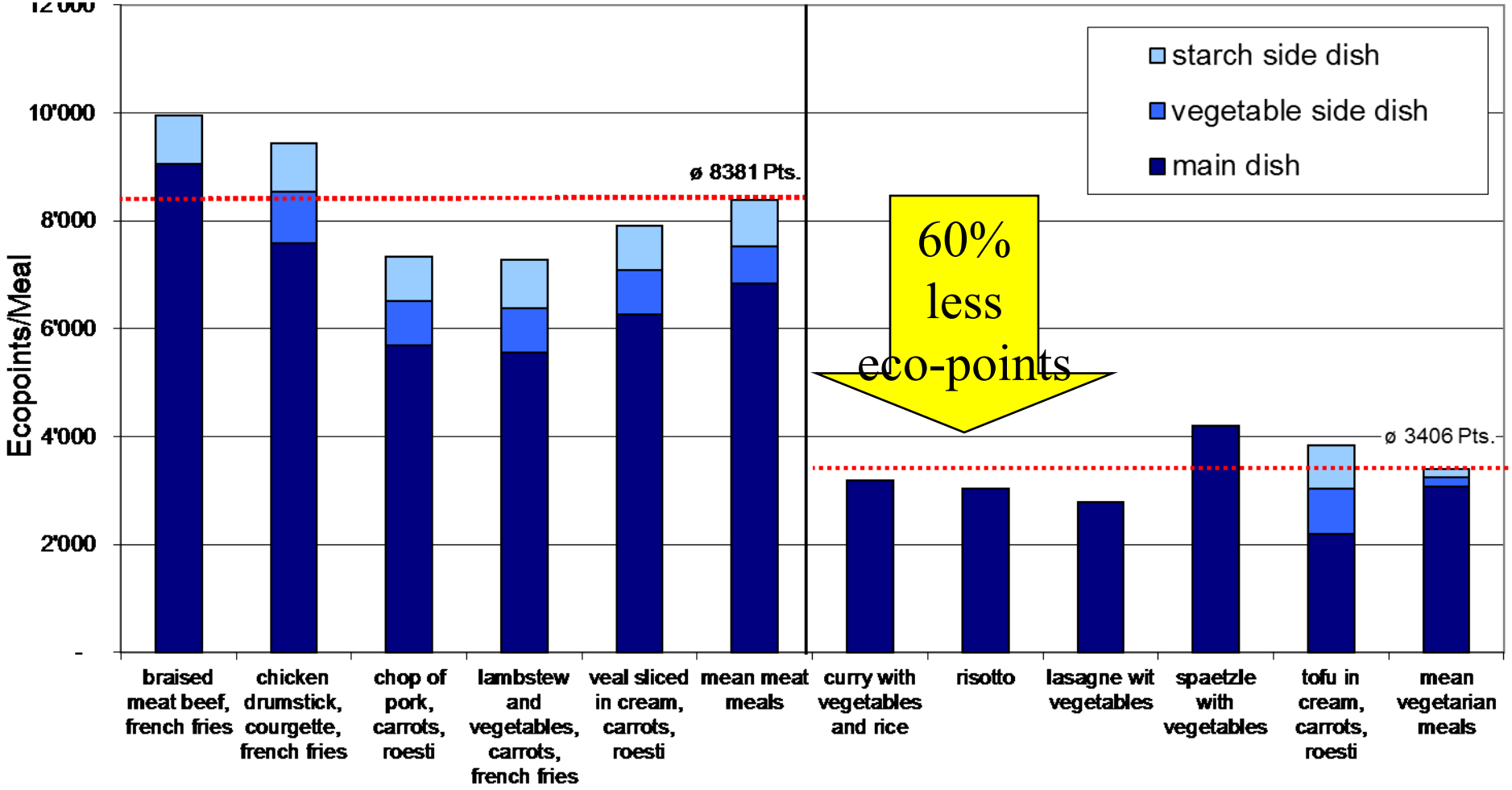
Organic products



- air, IPCC GWP 100a
- air, ozone depletion, UNEP 2000
- air, NMVOC
- air, acidification
- air, human health
- air, heavy metals
- water, eutrophication
- water, heavy metals
- water, radioactive
- water, toxic hydrocarbons
- soil, heavy metals
- soil, plant protection products
- resources, energy
- resources, land
- resources, mineral
- resources, water use
- waste

➢ Reduction potential about 16% if only organic food is bought

Vegetarian diet

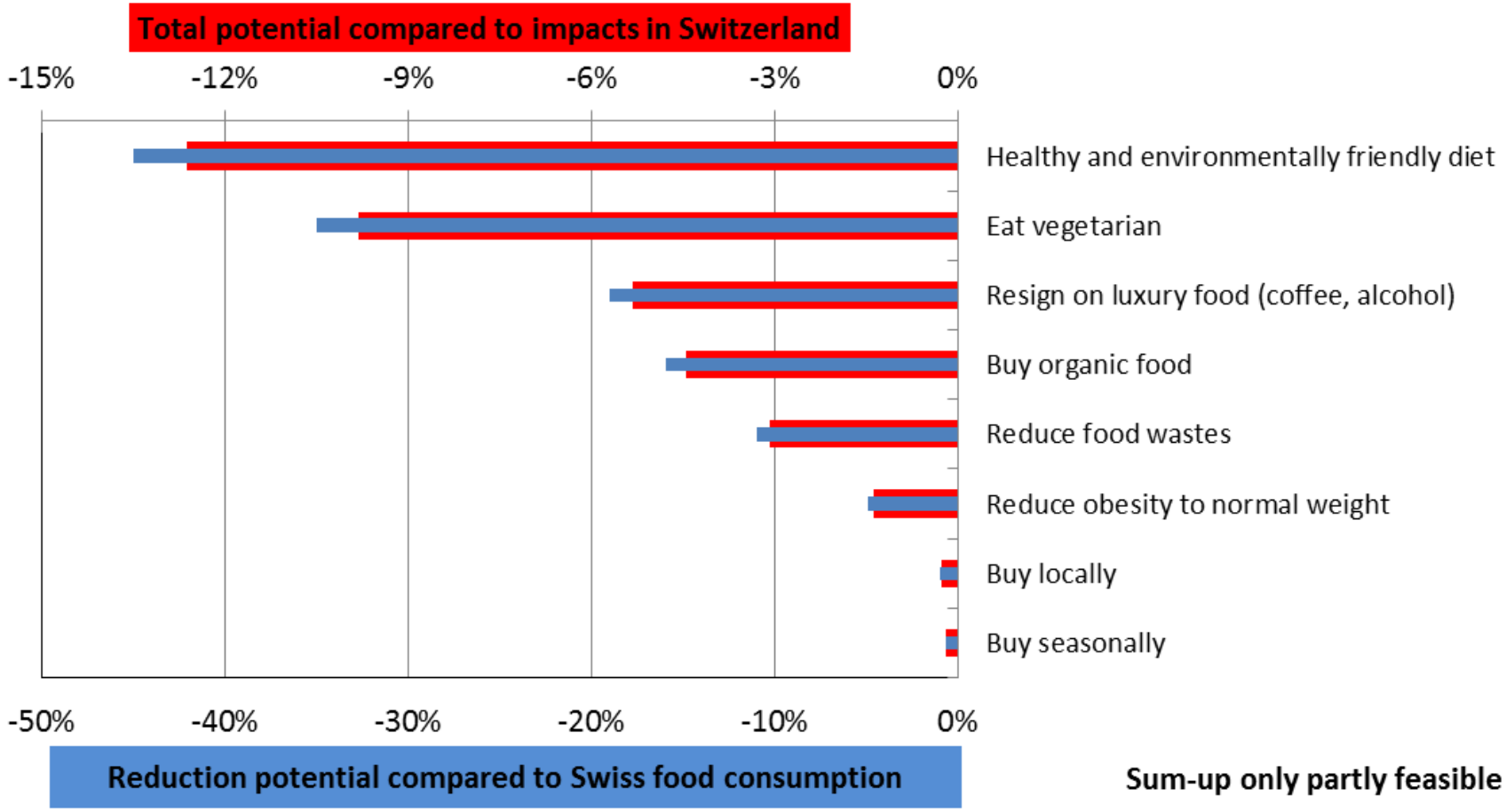


- Vegetarian diet reduces the environmental impacts considerable

TOTAL POTENTIALS

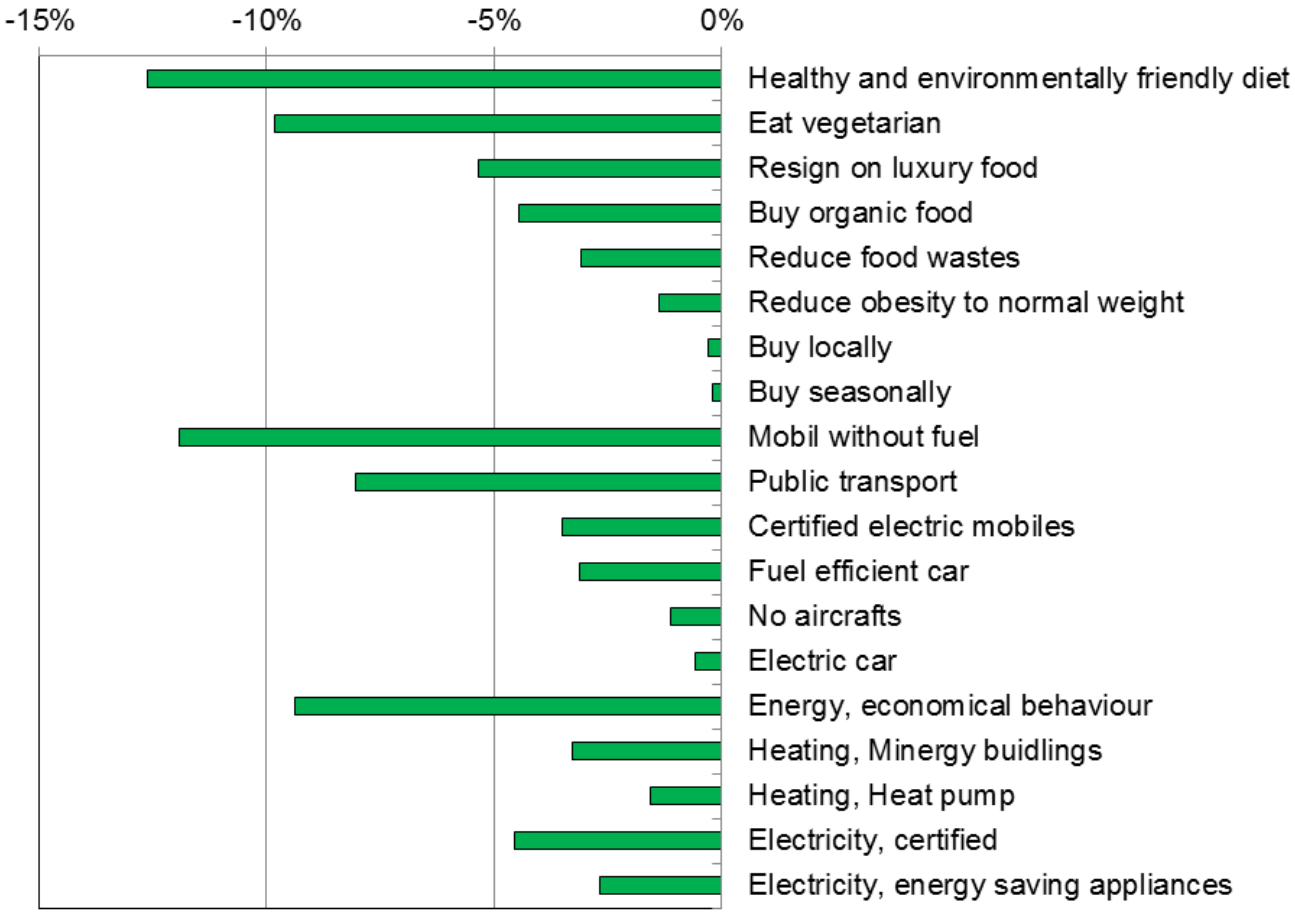
ANALYSIS FOR THE PRESENT SITUATION IN SWITZERLAND

Total potential for reduction of impacts



- Most relevant is a reduction of animal products
- Buying local/seasonal low potential because only vegetables and fruits affected

All consumption areas



- Vegetarian diet and substantial reduction of mobility demands have highest potentials
- Sum-up only partly possible

Summary

- Our methodology allows to investigate and compare the impacts of behavioural changes in all areas of consumption
- Most important are the areas of nutrition, mobility and energy use in households
- Combination of EE-IOA for broad overview and LCA for detailed analysis
- The highest potentials exist for a vegetarian diet, reduction of mobility and energy savings in households

ESU World LCA Food Database

Add on database for SimaPro

ESU-services global food database

- First work on cooking in India (1994-1995)
- Further development with Ph.D. thesis of Niels Jungbluth on meat and vegetable consumption in CH (1996-2000)
- Several projects of ESU-services for extension
- Today more than 2’500 datasets related to food production and consumption
- Background data and methodology according to ecoinvent v2.2
- Data can be provided for SimaPro and other software
- Costs depend on number of datasets and documentation

Contents ESU data-on-demand

- Simplified agricultural production services: application of fertilizers
- Vegetables: spinach, salad, tomatoes, lettuce, potatoes, onions, asparagus, etc.
- Fruits: apples, strawberries, cherries, grapes, oranges, vine, melons
- Animal products: pork, veal, beef, lamb, poultry, eggs
- Dairy products: butter, milk, milk powder, yoghurt, cheese

Contents (Part 2)

- Drinks: apple & orange juice, mineral water, tap water, beer, wine, milk, coffee
- Sweets: chocolate, cake, ice cream
- Meals: canteen, home-made, ready-to-eat
- Household appliances: cooking stoves and ovens, microwaves, refrigerators, carbonisation devices, coffee machine
- Food consumption: packages, transports, cooking, consumption patterns
- Pet food: cat food

Offers

- Background library for SimaPro with 1600 system processes as (2000 Euro)
- Price for single unit or system processes (300 CHF)
- Calculation of LCIA indicators (starting from 200 CHF)

Life Cycle Assessment of Swiss Chocolate

Niels Jungbluth, Alex König, ESU-services Ltd, Zürich

www.esu-services.ch

Key questions

- What are the differences between different types of chocolate?
- What are the environmental impacts of chocolate consumption?
- What are the most important aspects within the production of chocolate?
- Which potentials exist for the reduction of environmental impacts due to chocolate consumption?

Background

- Projects commissioned by German Aluminium Association (GDA) in cooperation with European Aluminium Foil Association (EAFA), Düsseldorf, Germany
- Büsser S. and Jungbluth N. (2009) LCA of Chocolate Packed in Aluminium Foil Based Packaging. ESU-services Ltd., Switzerland
- www.esu-services.ch/projects/packaging/
- Here we present our personal point of view

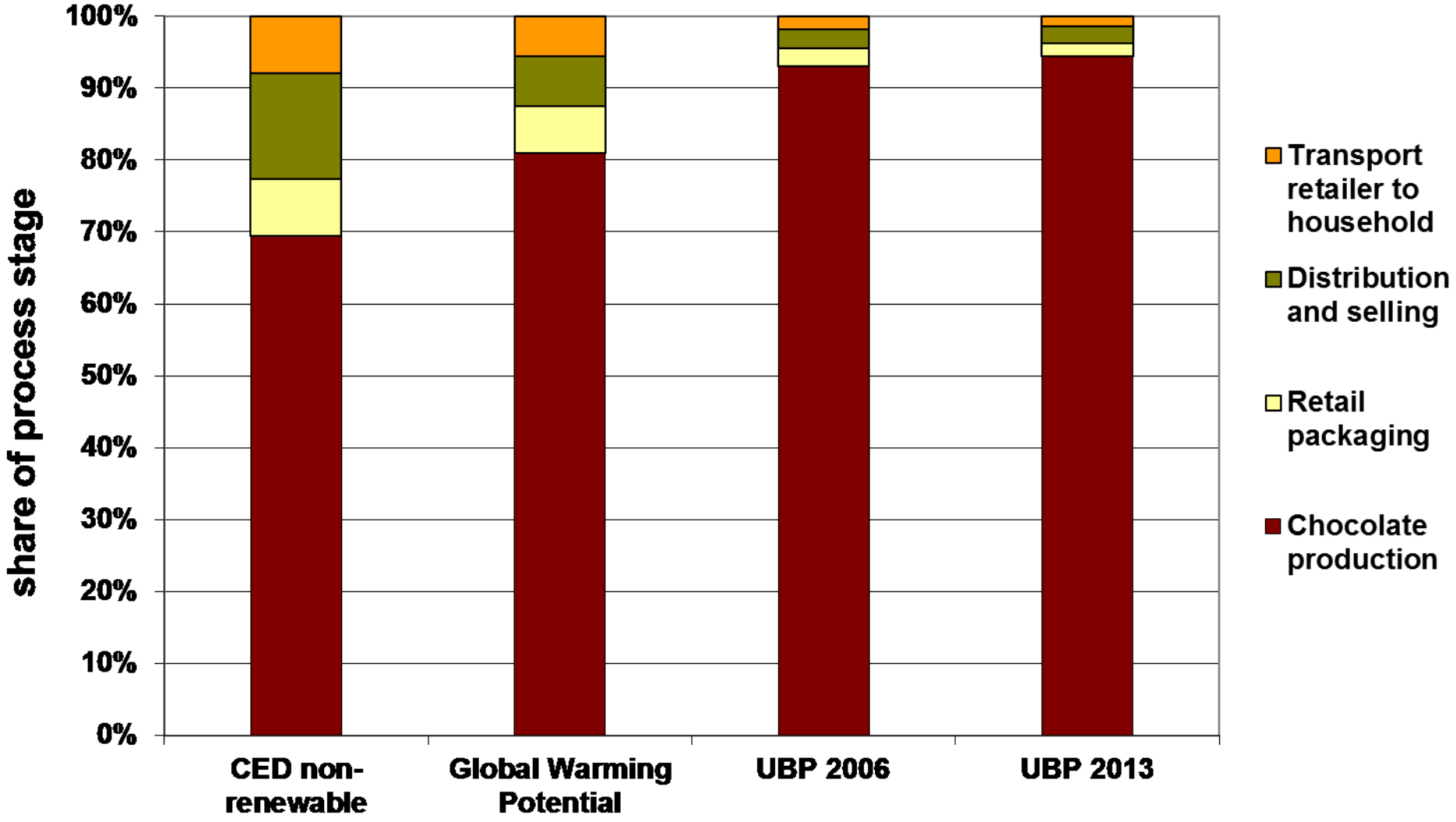
Goal and Scope for this study

- Functional unit: 1 kg of chocolate for consumption in the household
- Packed in aluminium foil and wrapped with paper
- Cocoa data from Ghana
- Consumption in Europe

Life cycle impact assessment

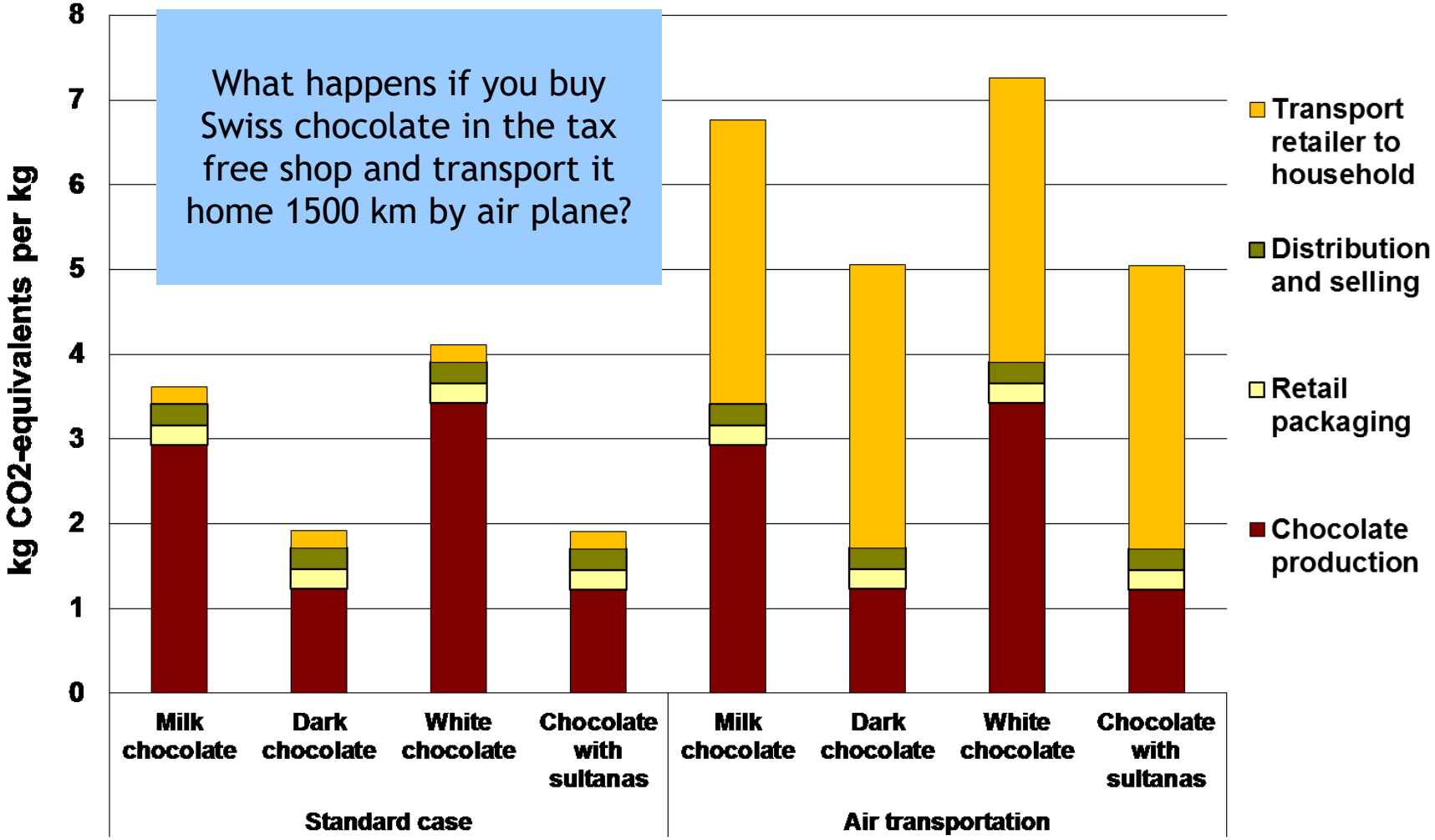
- Evaluation of CML impact categories in original study
- Here use of the LCIA method ecological scarcity 2013 (Switzerland) to simplify the presentation
- Evaluation of greenhouse gas emissions and cumulative energy demand as most common category indicators

Impacts per process stage



GWP: Comparison of different chocolates

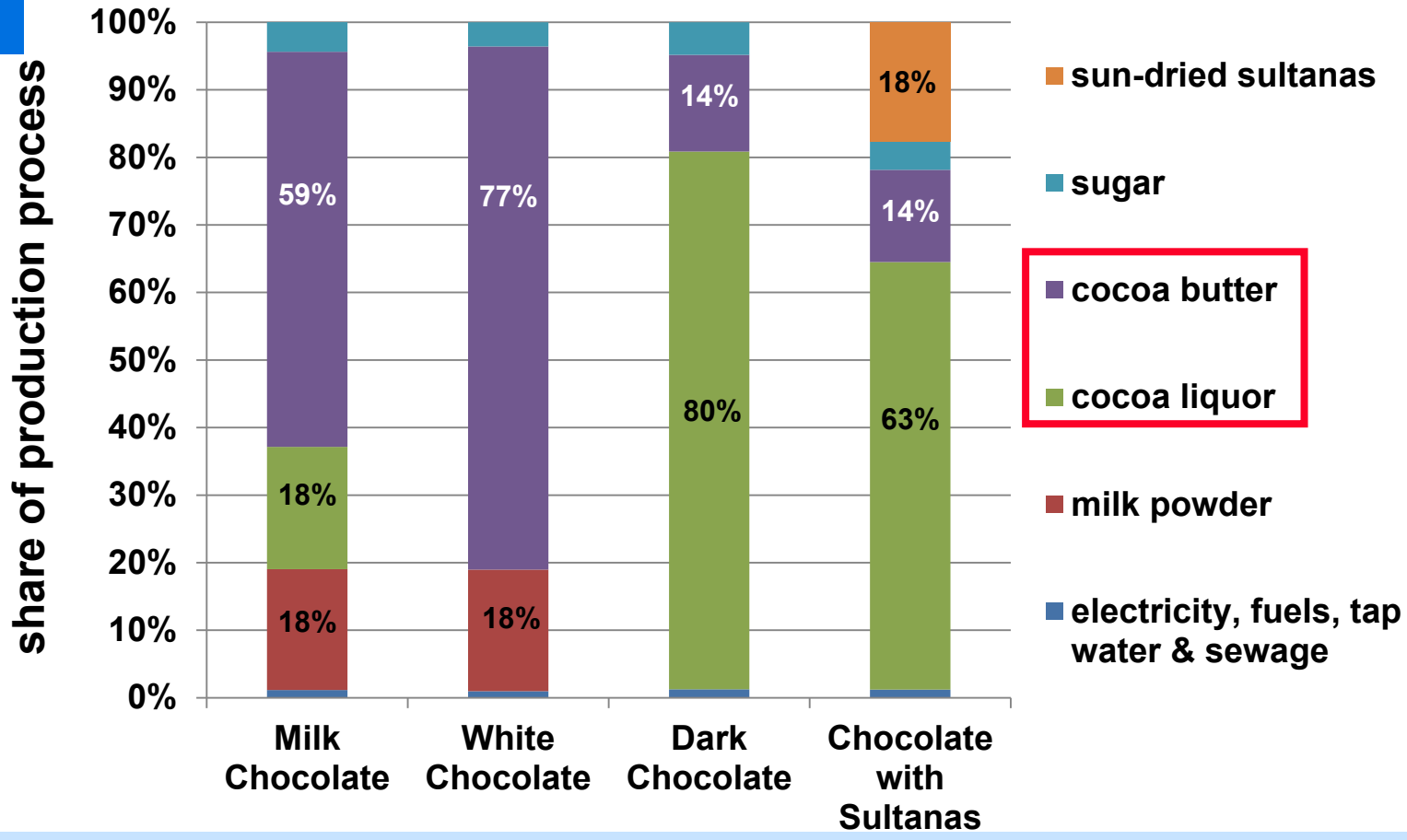
What happens if you buy Swiss chocolate in the tax free shop and transport it home 1500 km by air plane?



- Buy in tax free and 1500 km flying home can add considerable impacts

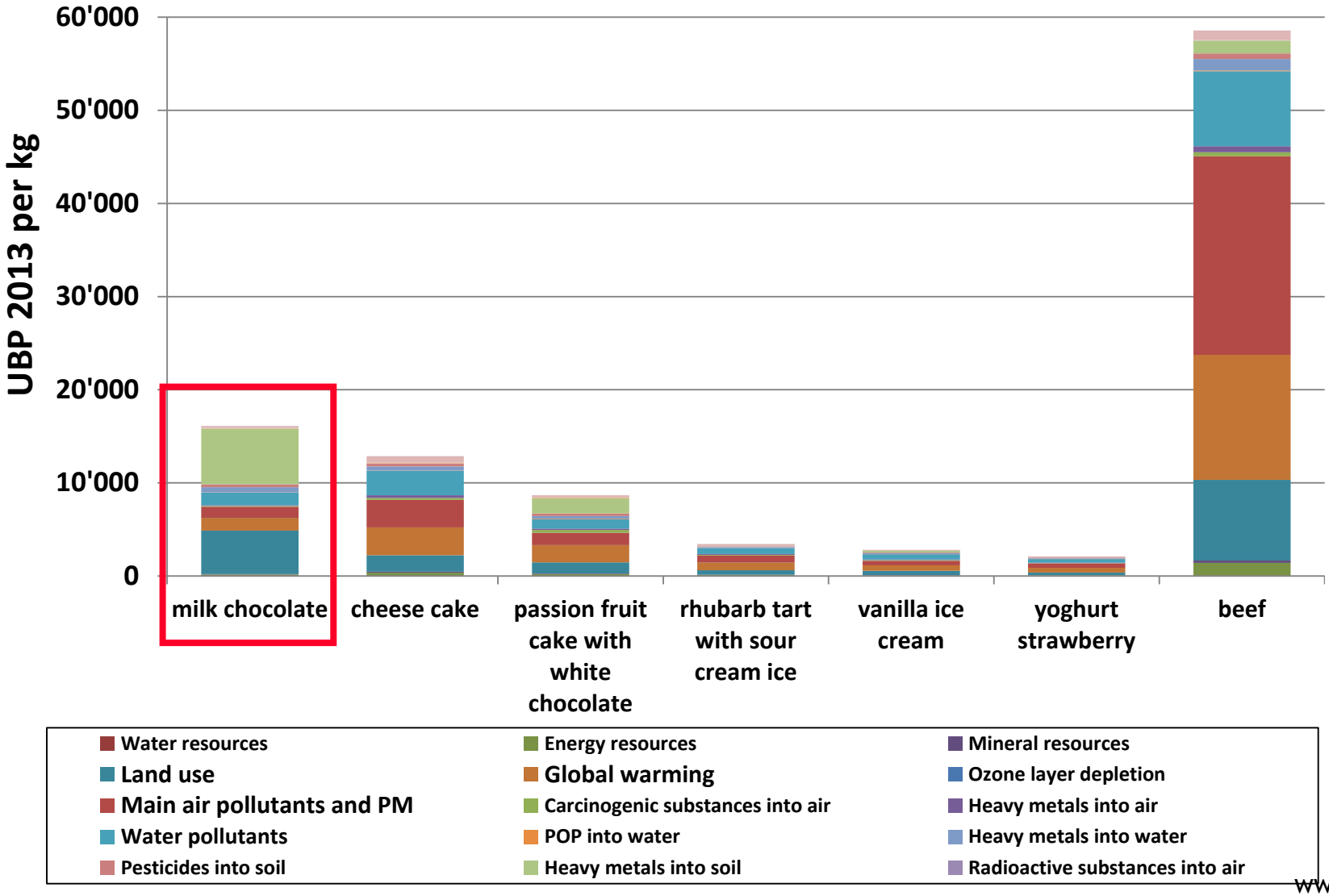
Shares in chocolate production

UBP 2013



- Land use and heavy metals into soil due to agricultural production of coca beans as main environmental impact factors

Chocolate and other food products



Summary

- Environmental impacts of chocolate are dominated by the agricultural production of cocoa beans and milk
- Packaging and distribution is of minor importance
- Dark chocolate has the lowest impacts
- Tax free chocolate transported by airplane can cause considerably higher impacts
- Chocolate is a product with comparable high impact

LCA Application for a Canteen Operator

commissioned by the Swiss SV group

Goal and Scope for the project

- Total food purchases
  - in 240 canteens
  - for 19.2 million meals
  - worth more than 150 Mio. CHF
- Functional unit: 1 meal served
- Share of different types of ingredients?
- Improvement potentials developed together with WWF and ewz (energy supply)

Data collection in a modular LCA

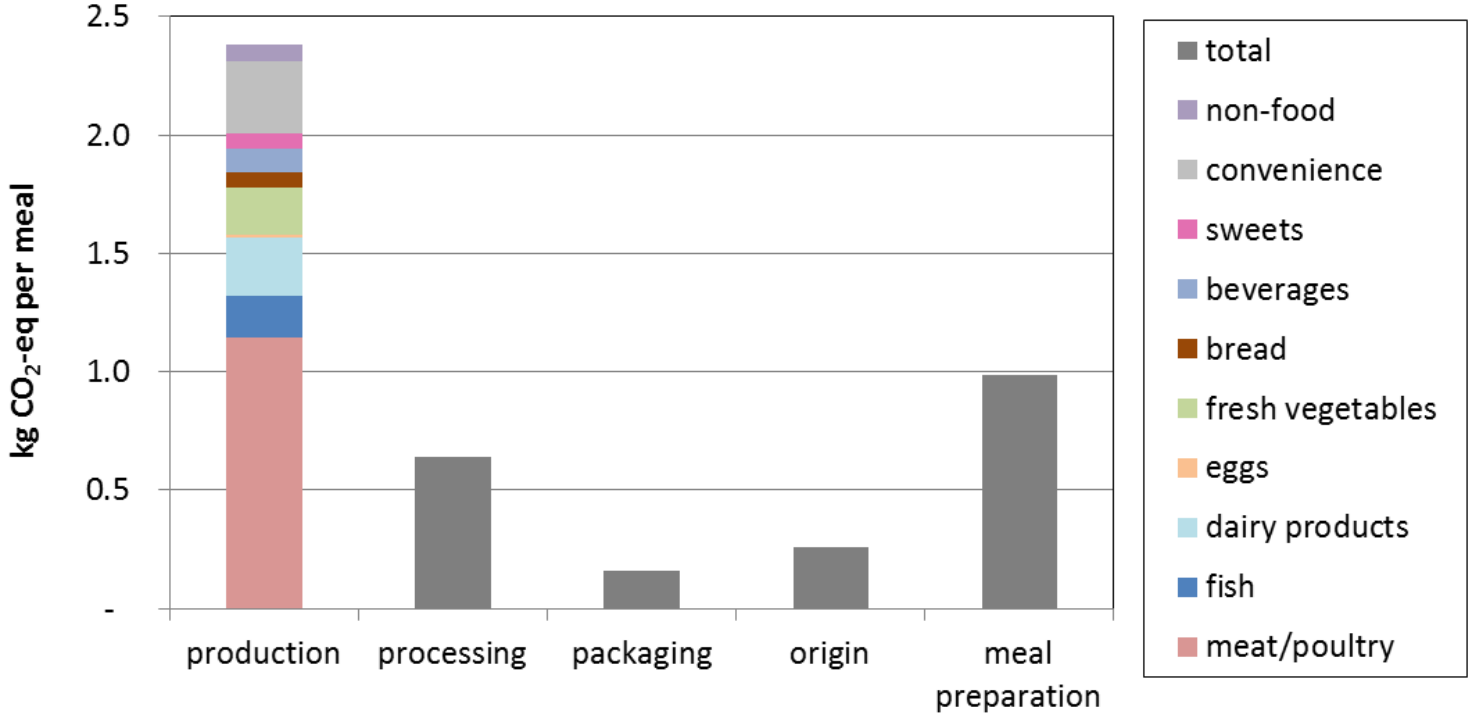
- Inventory of 12’000 articles purchased from different suppliers
- Total purchase of 21’000 tonnes food and non-food
- Linked to 200 different type of products in ESU data-on-demand database
- Further coverage of packaging, type of conservation, origin and mode of transport

Composition of the average canteen meal

Product group	grams per meal
meat/poultry	108
fresh vegetables	310
bread	108
dairy products	135
eggs	5
fish	21
sweets	32
convenience	137
beverages	225
non-food	42
Share organic	*<1*
Share CH/ship/air-transported	*61% / 9.5% / 0.5%*

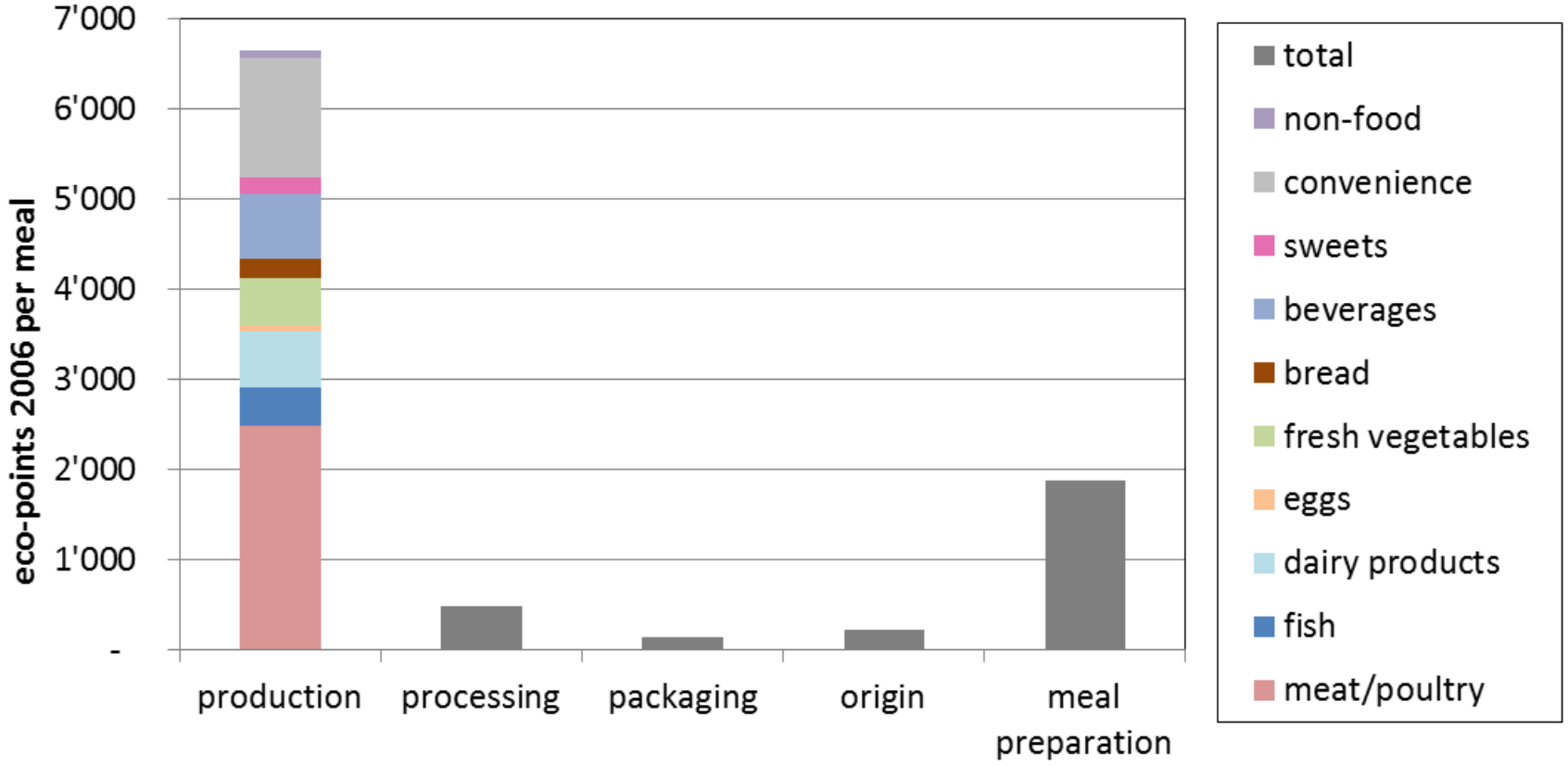
GWP of meal preparation in canteens

87.000 t CO2-eq per year (66.000 t CO2-eq goods and 21.000 by preparation)



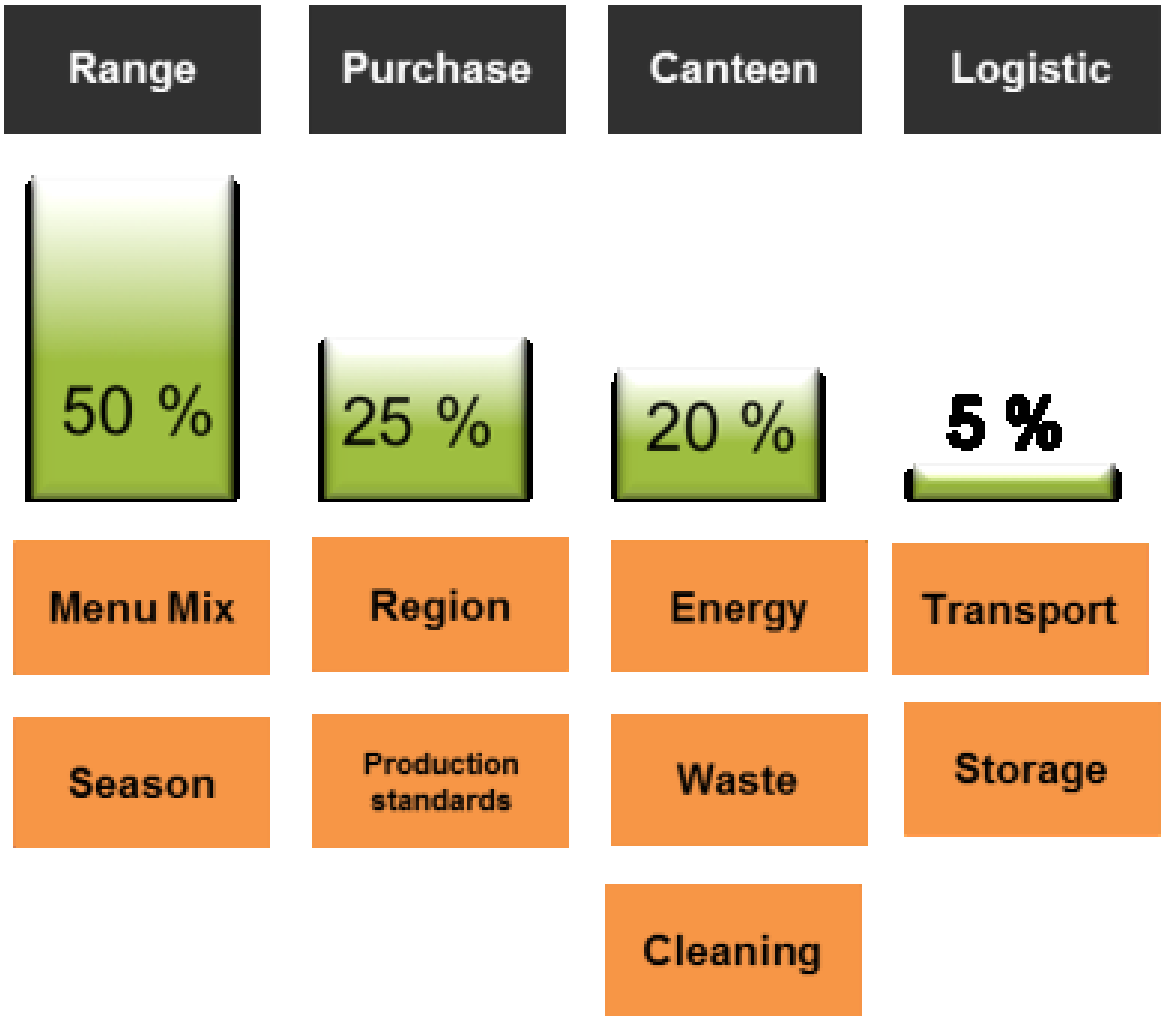
- Production of food much more important than preparation
- Meat and fish dominate the results with more than 50%

Full LCIA of total purchases per meal



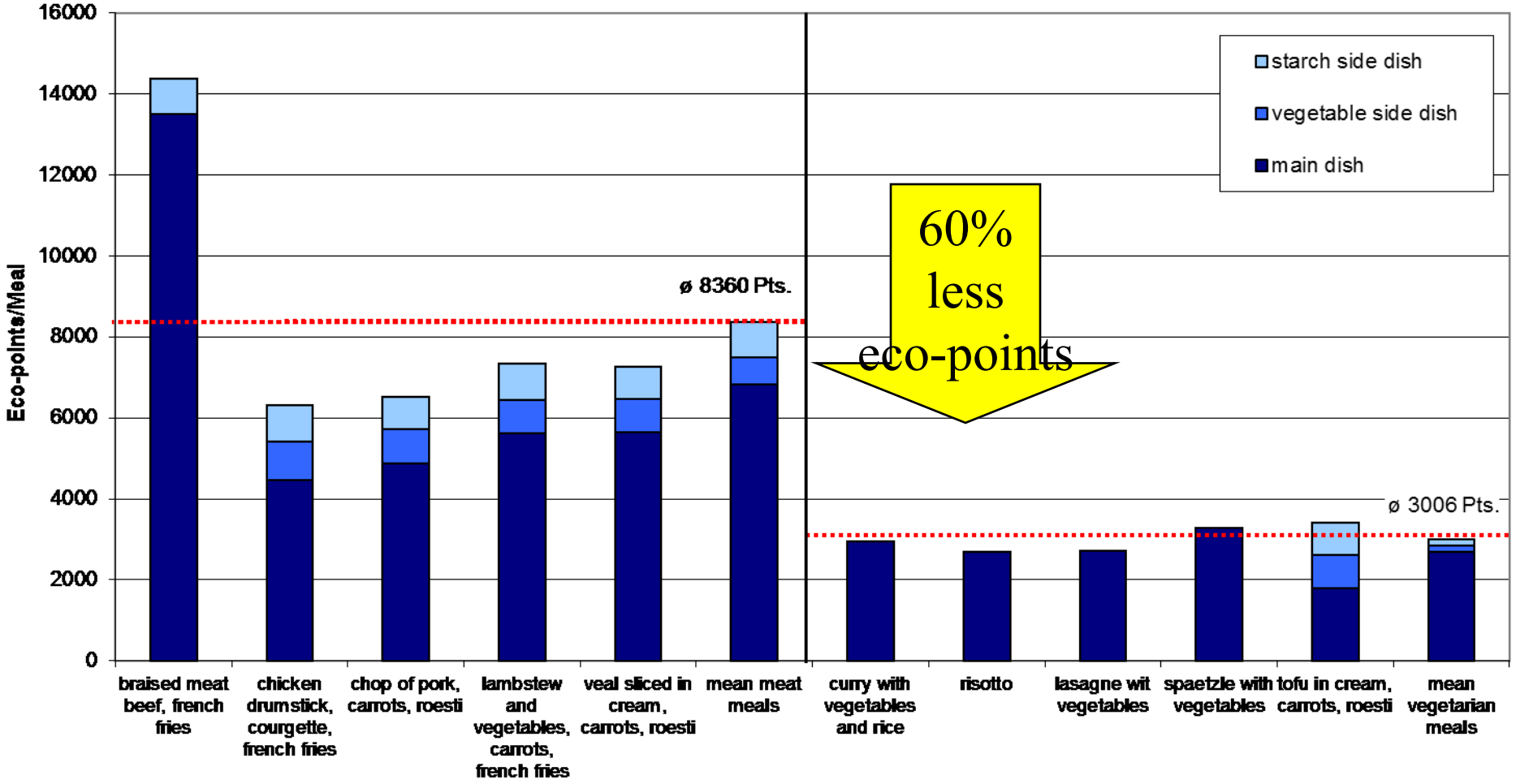
- Supply chain and agricultural production even more important in a full LCIA

The programme ONE, TWO, WE



- Customer can choose between improvement options for their canteen

Improvement: Vegetarian canteen meals



- Vegetarian meals reduce the environmental impacts considerable

Improvement: Season calendar for fruit and vegetables

kg CO2-eq per kg vegetable		Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Green asparagus	CH-Lorry	n.a.	n.a.	n.a.	1.9	1.9	1.9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	ES-Lorry	n.a.	n.a.	n.a.	2.1	2.1	2.1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	MX-Air	22.7	22.7	22.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	PE-Air	24.9	24.9	n.a.	n.a.	n.a.	n.a.	24.9	24.9	24.9	24.9	24.9	24.9
	US-Air	n.a.	18.7	18.7	18.7	18.7	18.7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Zucchini	CH-Lorry	n.a.	n.a.	3.9	3.9	0.6	0.6	0.6	0.6	0.6	3.9	3.9	n.a.
	ES-Lorry	0.9	0.9	0.9	0.9	n.a.	n.a.	n.a.	n.a.	n.a.	0.9	0.9	0.9
	IT-Lorry	0.7	0.7	0.7	0.7	n.a.	n.a.	n.a.	n.a.	n.a.	0.7	0.7	0.7
	MA-Lorry	1.0	1.0	1.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1.0	1.0
Zucchini TK	FR-Lorry	1.8	2.0	2.2	2.3	1.1	1.1	1.1	1.1	1.1	1.3	1.5	1.6
Zucchini TK	CH-Lorry	0.7	0.7	0.7	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7

- Assessment of global warming potential
- Season calendar to assess monthly routes
- Main difference: heating greenhouse and air freight

Main Improvement options followed up

- Less meat per meal and more vegetarian meals
- Supply chain management for vegetables from heated greenhouses
- Reduction of air-transportation
- Less food waste

- Each customer can choose the extra services and offers for their canteen
- Goal: 10% less CO2-eq or -6000 tonnes in 2015

Status after the first year

- 42 canteens participating
- 418 Tonnes of CO2-eq saved, 5.5% reduction
- SV purchased 54 tons less meat and fish and at the same time 35 tons more vegetables
- Reduction of 35% air-transportation saved 5 tonnes of CO2-eq

Conclusions

- Life cycle management is necessary and feasible to reduce environmental impacts of canteens
- In-depth LCA analysis helps for internal and external argumentation
- Collaboration with suppliers in order to reduce impacts in the supply chain is necessary
- The holistic approach on environmental improvements was welcomed by many customers and guests

The SENSE Tool for SME's

Seventh Framework Programme of the European Union

Question

How can we develop a tool

for the SMEs in the food sector

to do a simplified

life cycle assessment?

INTRODUCTION

Context of the SENSE-project

- 23 Partners from 13 countries
- Aimed at SMEs in food supply chains
  - Fruit industry, aquaculture, meat & dairy industry, expendable
- End of the project was January 2015
- Further information on www.senseproject.eu

What is the objective of SENSE?

Develop a harmonised system for environmental impact assessment of the food and drink industry

- Online tool for calculating environmental footprints
  - Cooperation over the supply chain in the tool
  - Includes social aspects
  - Regionalized approach (certain impact categories)
- Environmental Identification Document
  - Added value

Importance of SMEs for Europe

European Union

- 99% of all enterprises in the private economy
- 2 of 3 jobs

SENSE TOOL METHODS

Data used for the assessment: KEPIs

Definition:

- KEPIs are «Key environmental performance indicators»
- For each production step, linked to key environmental challenges
- Simple to measure & easy to understand
- Built on accessible production data, e.g.
  → Litre diesel use per kg feed produced

Evaluation:

On average, **95%** of the total environmental impact can be assessed with the selected indicators compared to a full LCA

Impact assessment

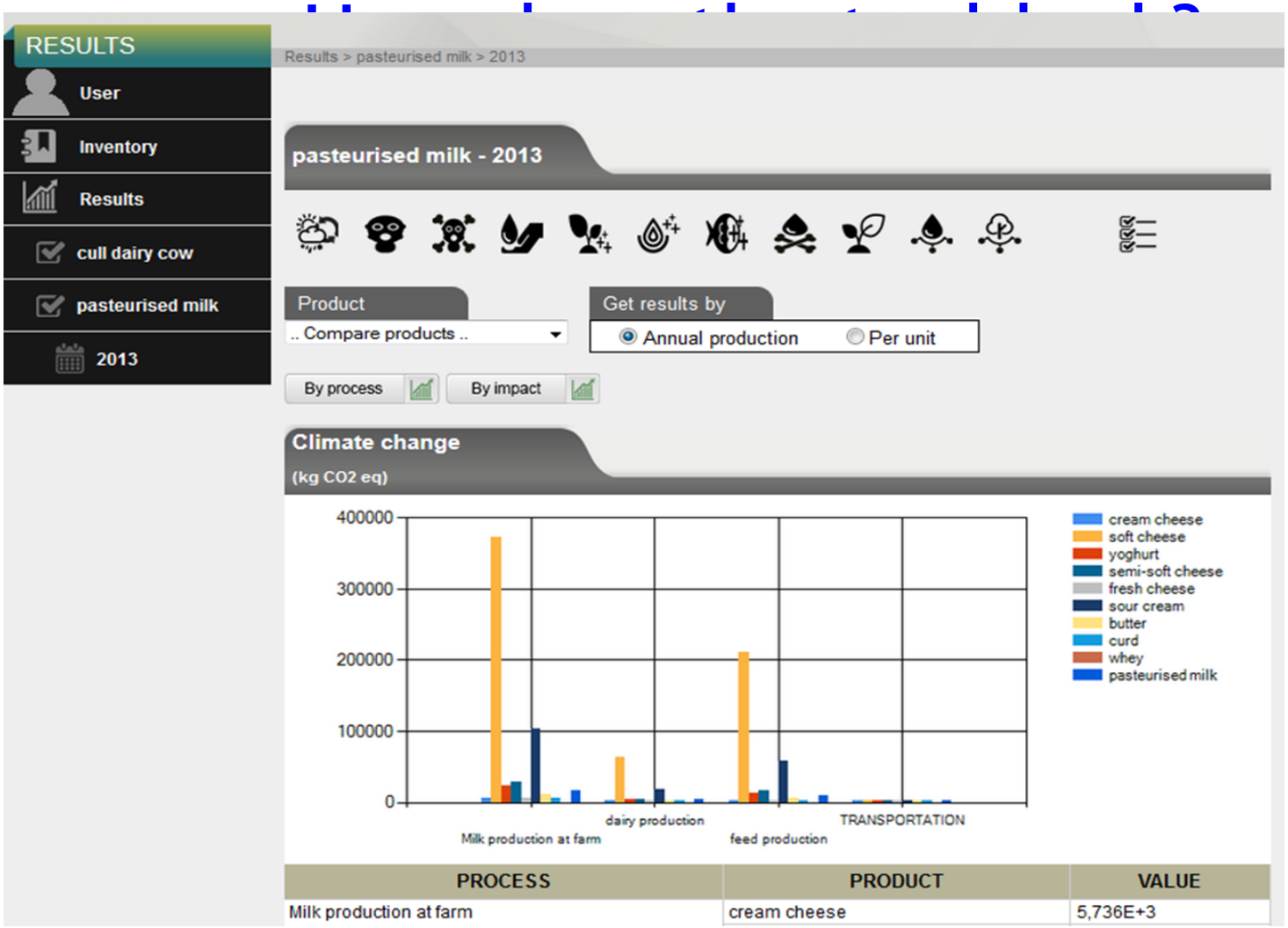
A set of consistent environmental impact assessment methods and indicators

Decision: Choice of methods from the ENVIFOOD Protocol

- The protocol is based on ISO, the ILCD handbook and the PEF guide (European Commission on the Product Environmental Footprint)
- Different method to assess water use

Abiotic resource depletion, acidification, climate change, freshwater ecotoxicity, eutrophication (freshwater, marine, terrestrial), human toxicity (cancer, non-cancer), land use, water resource depletion.

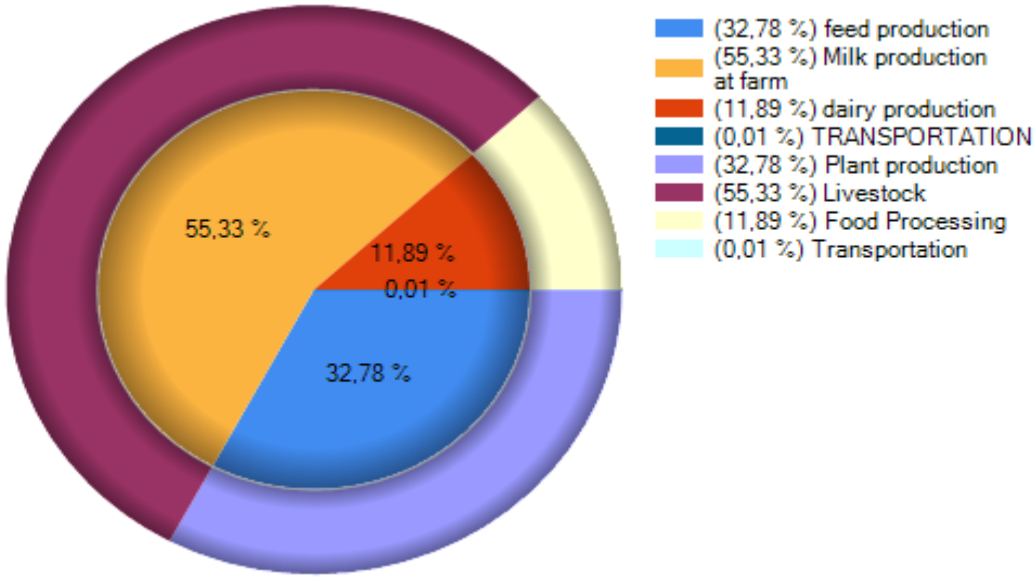
THE SENSE-TOOL


RESULTS
User
Inventory
Results
cull dairy cow
pasteurised milk
2013
Results > pasteurised milk > 2013
pasteurised milk - 2013
Product
.. Compare products ..
Get results by
Annual production
Per unit
By process
By impact
Climate change
(kg CO2 eq)
400000
300000
200000
100000
0
Milk production at farm
dairy production
feed production
TRANSPORTATION
cream cheese
soft cheese
yoghurt
semi-soft cheese
fresh cheese
sour cream
butter
curd
whey
pasteurised milk
PROCESS
PRODUCT
VALUE
Milk production at farm
cream cheese
5,736E+3

Example result: 1litre milk, climate change

- Entered KEPI data are analysed with chosen method
- SMEs can
  - gain insight in the share of environmental impacts of the different production steps
  - Define hotspots
  - Compare perfomance over the years

Milk production at farm
Feed production
Dairy production



CONCLUSION:
SMES AND THE SENSE TOOL

The SENSE-tool – designed for SMEs

- Online tool
  - No installation of new software
  - Easy accessible, also for suppliers
- Intuitive, user friendly design
  - Food chain is visualized with symbols
- Regionalized data is automatically included
  - E.g. water use is calculated with data from chosen country

The SENSE-tool: Difficulties for SMEs

- SMEs need valuable time to collect data
  → No full LCA, only key data asked
  → Step-by-step description & short film
- Dairy SMEs feel uneasy asking suppliers (farmers)
  → Confidential
  → Direct entry of data possible (Guest)
- EID not well known yet, advantage not visible for SMEs
- LCIA indicators difficult to explain for non-LCA experts

➡ SMEs expect quick results based on small amount of data

The SENSE-tool: Advantages for SMEs

- Less time consuming than a full LCA
- Less costs than a full LCA
- Overview over impacts of different processes
  → define hot-spots
- Comparison between different years
- Benchmarking
- Added value with the Environmental Identification Document (EID) that summarizes main impacts
  → brand differentiation

Sources

- Ramos, S. et al, Oct. 2014:
  «Sense tool: Easy-to-use web-based tool to calculate food product environmental impact»,
- Public Deliverables 1.1, 1.3, 2.2 from the project can be retrieved from:
  http://www.senseproject.eu/public-deliverables
- Contributions by ESU-services
  http://www.esu-services.ch/projects/lcafood/sense/
- «Fakten und Zahlen über die kleinen und mittleren Unternehmen (KMU) der EU»
  http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/index_de.htm 8.9.2014, 4 p.m.

Food losses in the Life Cycle of Lasagne Bolognese: ready-to-serve vs. home-made

alufoil
European Aluminium Foil Association

Key questions

- What is better from an environmental point of view? Ready-made lasagne or home-made lasagne?
- How do the following factors influence the performance of both types of lasagne?
  - amount and type of food waste
  - energy consumption in production and preparation
  - efficient preservation vs. fresh ingredients

Important system boundaries

- Ready-made vs. home-made lasagne
- FU: Preparation of two portions (400g) of lasagne Bolognese ready to be heated in oven at home
- Same composition for both types of lasagne
- Ready-made packed in aluminium container, chilled
- Fresh ingredients: seasonal, conventional, regional

- Food waste data from Gustavsson et al. (2011), Kranert et al. (2012), Lorrayne (2008) and industry data

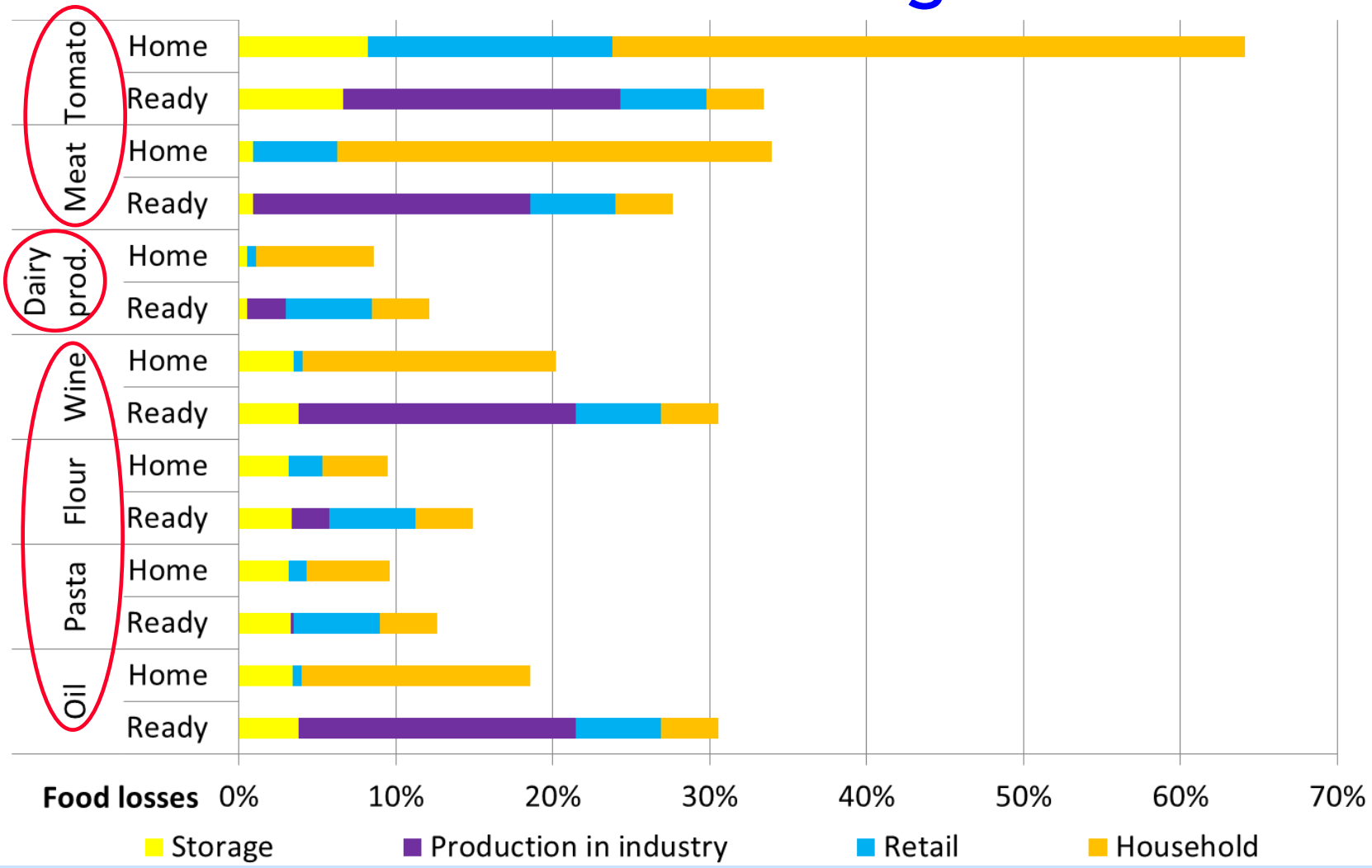
Challenges and points of discussion

- Is it possible to compare home-made and ready-made lasagne as they have different functions?

  →How can we generally deal with slightly different functions in LCA?

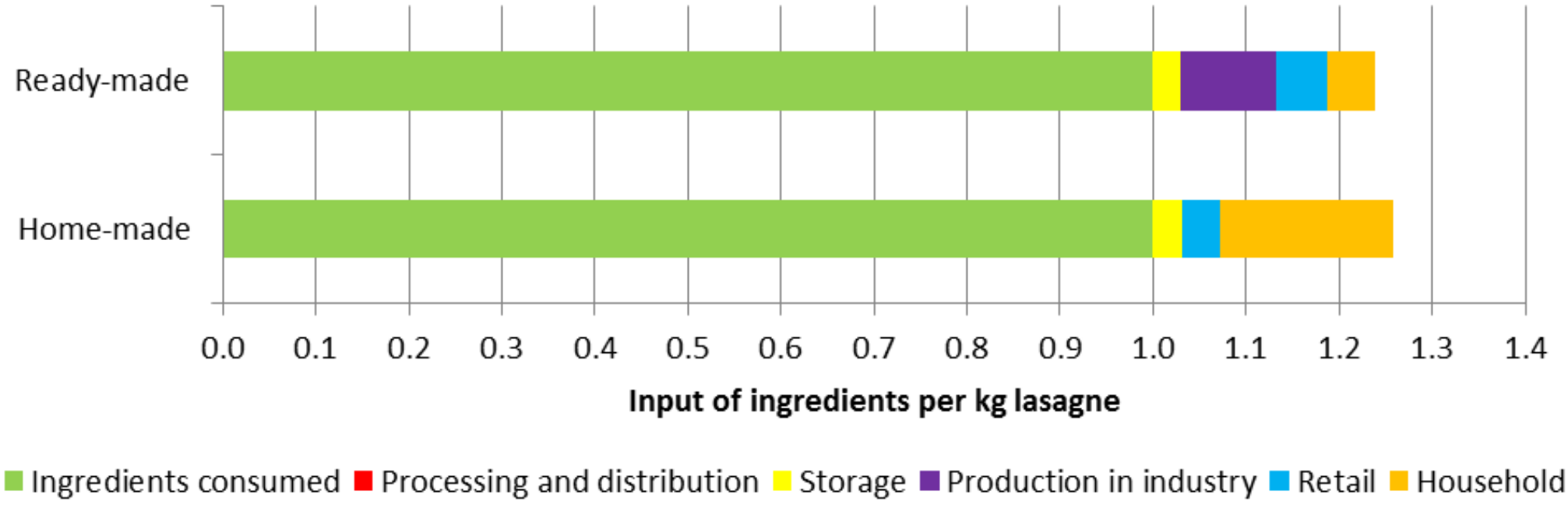
- How valid is a portion size of 400g for both products?
- Can it be assumed that the left overs on the plate are the same due to the same portion size?

Losses of selected ingredients



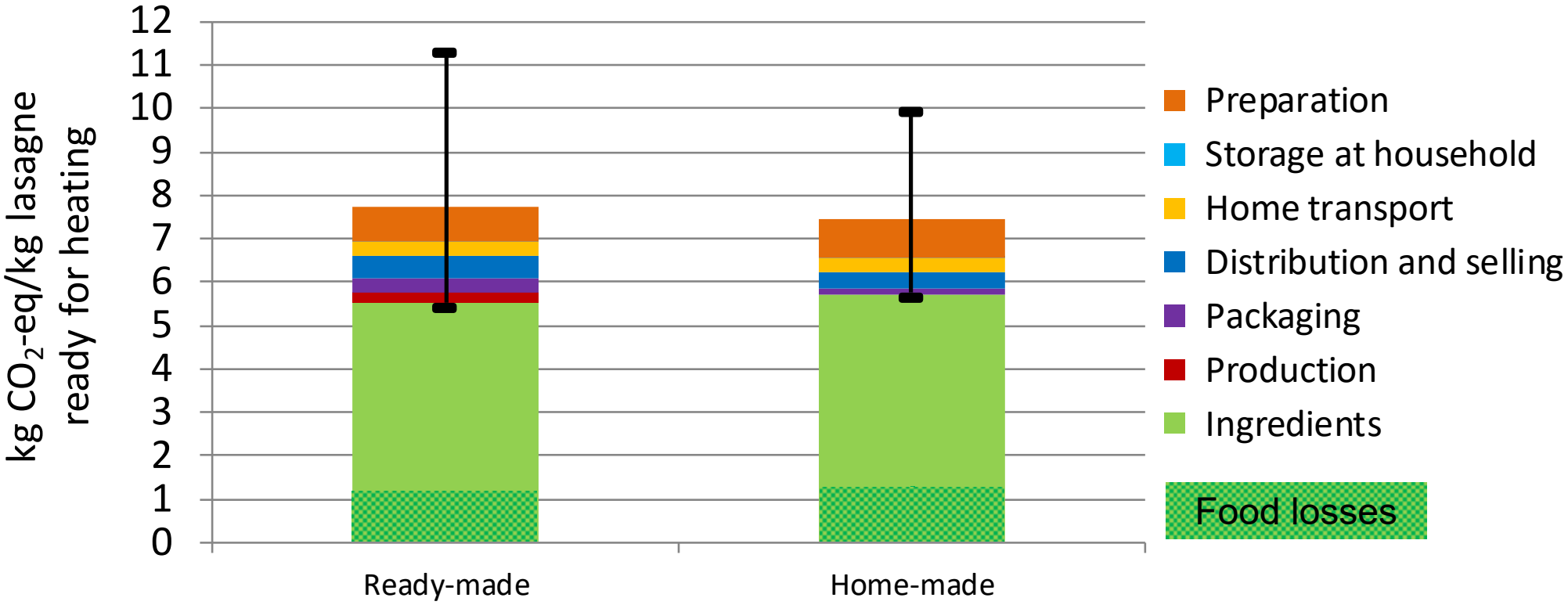
➢ Ready-made lasagne leads to more food losses for conservable ingredients

Food losses



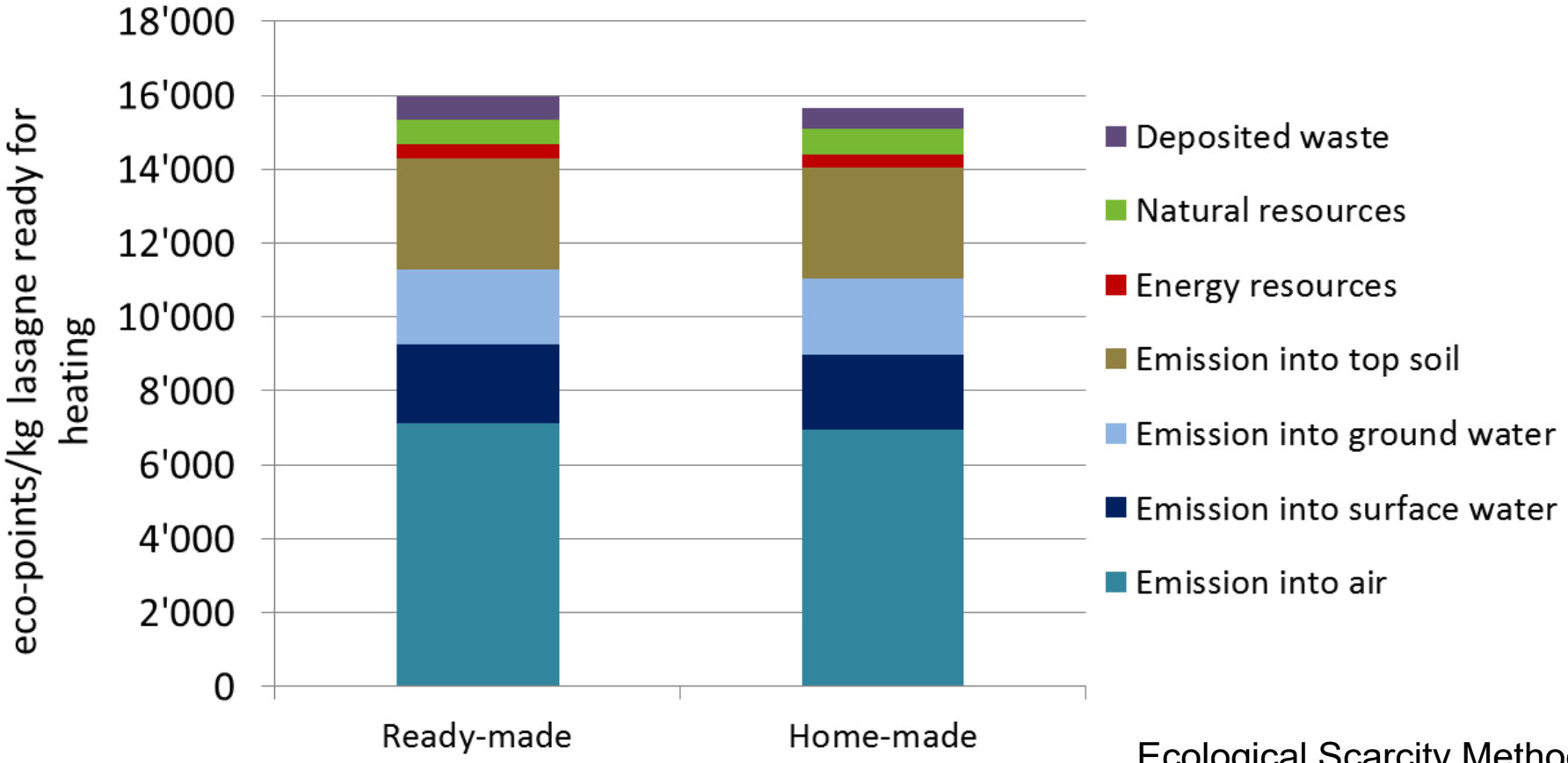
- Total about the same (24% to 26% losses from farm to oven)
- Differences in the life cycle stages

Greenhouse gas emissions



- Total GHG emissions about the same
- High uncertainties
- Main differences in distribution, production and preparation

Total environmental impacts



Ecological Scarcity Method 2006

- Total environmental impacts are comparable
- Ingredients production is most important

Summary

- No clear ranking of losses or impacts is possible
- Ready-made lasagne leads to more food losses for conservable ingredients than home-made lasagne
- Differences not based on the food losses but on energy consumption for preparation and storage, packaging etc.
- Ingredients are most important

- Best case assumption for fresh ingredients → greenhouse production or ingredients from abroad worse impacts
- Function of both products is slightly different

General conclusions

- Food losses are important when considering environmental impacts of food consumption
- More and better data is needed in order to make detailed comparisons
- Avoidance of food losses can reduce costs and environmental impacts

Granted, my car consumes a lot ... But, Your Californian asparagus needs also 5 liters per kg!

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