

Environmental impacts of Swiss consumption and production: A combination of input-output-analysis with life cycle assessment

Dr. Niels Jungbluth

ESU-services Ltd., Uster, Switzerland



45th LCA Discussion Symposium
Berne, 15. September 2011

Project Goals

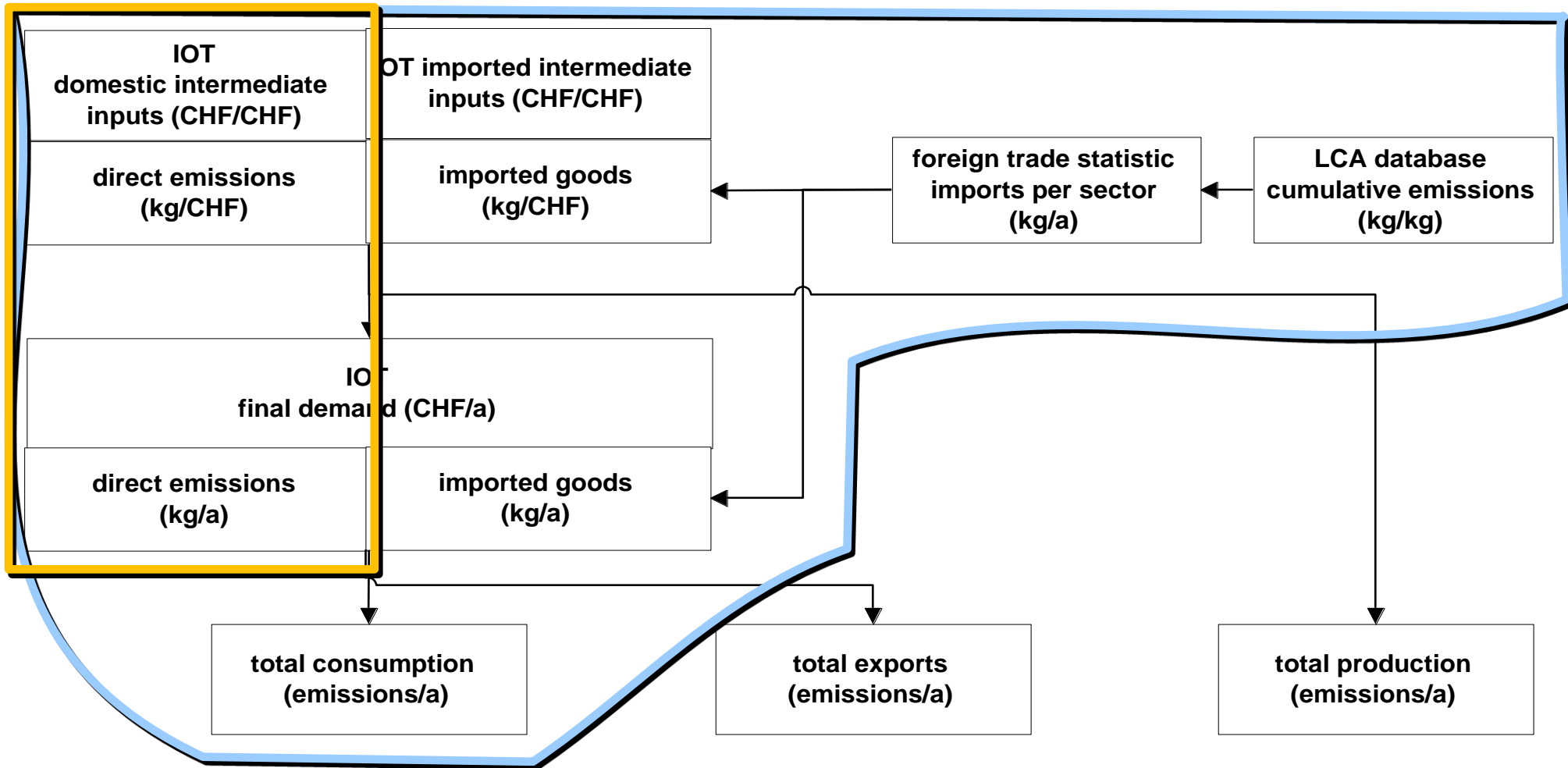
- Develop a method for comprehensive analysis of environmental impacts in Switzerland (pilot project)
 - A production and consumption perspective
 - All relevant environmental issues
 - Combination of EE-IOA¹⁾ and LCA
- Set up a data base for analysis with reference year 2005
- Provision as SimaPro data for further analysis
- Identify most important areas of consumption and production

¹⁾ Environmentally Extended Input-Output Analysis

Outline of presentation

- **Data sources** for domestic and imported emissions and resource uses
- **Methodology** for linking LCA and economic data
- Impact assessment and results of analysis
- **Conclusions**
 - Key figures
 - Policy recommendations
 - Methodological issues

Combination of methods and data



➤ Several data sources are combined for the analysis

Life cycle impact assessment

	LCIA method:	One environmental issue		Several issues	
		CED	Carbon footprint	Ecological footprint	Ecological scarcity 2006
Resources	Impact category				
	Energy, non-renewable	√	∅	∅	√
	Energy, renewable	∅	∅	∅	√
	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		∅	∅	∅	∅

Carbon Footprint, CED:

Ecological footprint:
easy to understand, low

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

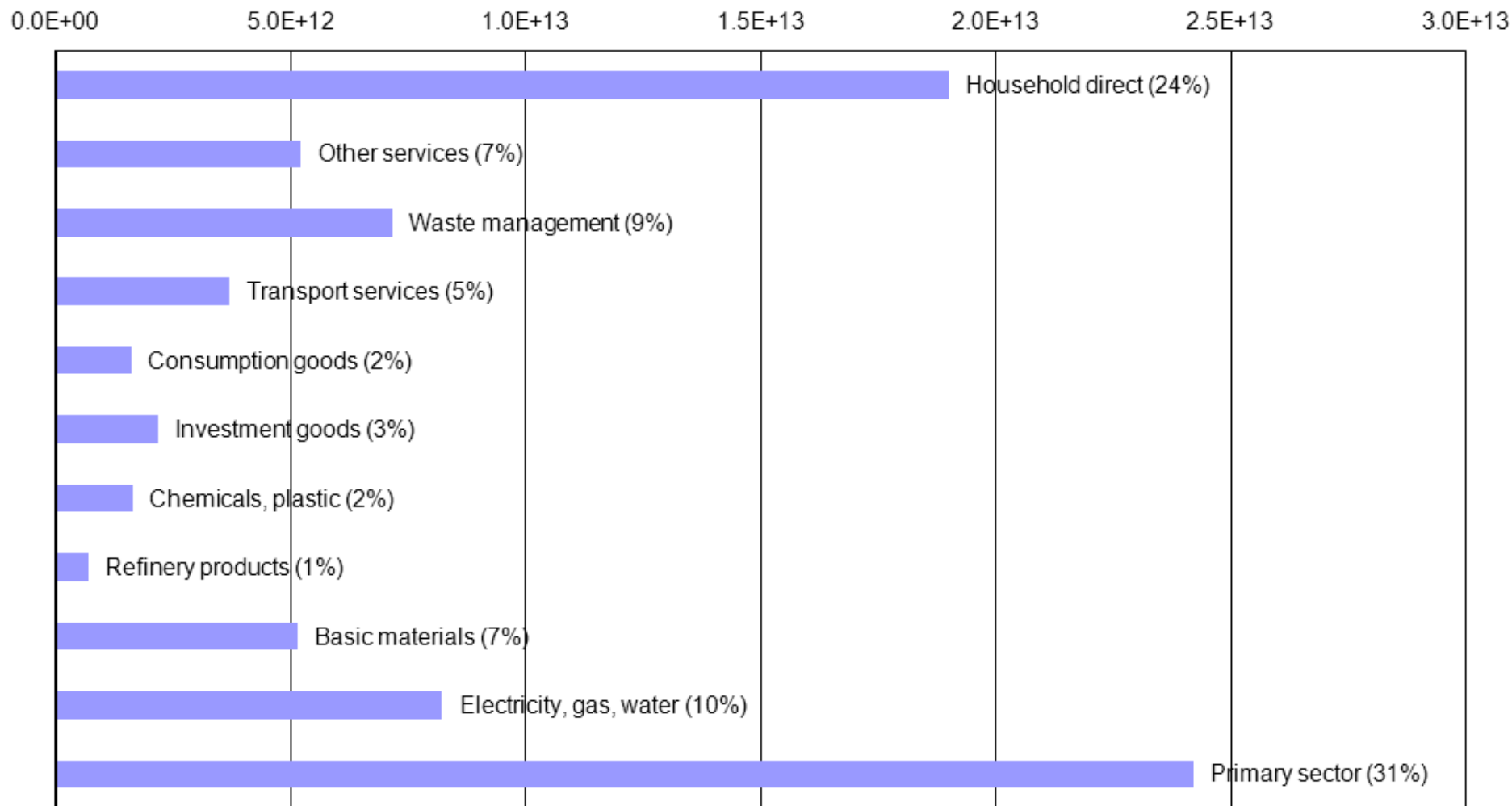
- It is necessary to have one indicator that covers a range of environmental impacts
- Many stakeholders in Switzerland use the ecological scarcity method 2006

Data sources: Domestic Emissions

- Greenhouse gases and energy use according to BFE/BFS project for IOA (residence principle)
- All other emissions and resource uses according to current flows in the ecological scarcity method 2006 (territorial principle)
- Allocation to sectors and consumption based on information in basic data sources, GHG and energy allocation

Production perspective

total eco-points in 2005 due to domestic emissions and resource uses



➤ Primary sector most important for emissions in Switzerland

Data sources: Imports

- Foreign trade statistics in physical units (kg/a)
- ecoinvent data v2.2
- ESU data-on-demand (food and consumer goods)
- Matching physical units in trade statistics with monetary units of IOA (kg import goods per CHF import goods)

EcoSpold data: Imported Goods

Name	Location	InfrastructurePro	Unit	SITC-01, meat and meat preparations, import	SITC-01, meat and meat preparations, export	Unit	Faktor	meat and meat preparations	import	export
Location				CH	CH				103'102'216	9'521'410
InfrastructureProcess				0	0				103'102'216	9'521'410
Unit				kg	kg				103'102'216	9'521'410
transport, freight, rail	CH	0	tkm	0	8.36E-2	km	200	transport statistics	-	41.8%
transport, lorry >28t, fleet average	CH	0	tkm	0	1.14E-1	km	200	transport statistics	-	57.1%
transport, barge	RER	0	tkm	1.40E-1	8.15E-3	km	800	transport statistics	-	1.0%
transport, freight, rail	RER	0	tkm	8.25E-2	0	km	600	transport statistics	13.8%	-
transport, lorry >16t, fleet average	RER	0	tkm	4.09E-1	0	km	600	transport statistics	68.1%	-
transport, aircraft, freight	RER	0	tkm	3.46E-2	2.55E-3	km	5000	transport statistics	0.7%	0.1%
transport, transoceanic freight ship	OCE	0	tkm	1.74E+0	0	km	10000	transport statistics	17.4%	-
beef, IP, at slaughterhouse	CH	0	kg	9.31E-2	4.43E-4	011.00	1	Fleisch von Rindern, frisch, gekühlt oder gefroren	9'600'728	4'218
meat mixed, IP, at slaughterhouse	CH	0	kg	8.05E-1	8.64E-1	012.00	1	Fleisch (ohne solche Schlachtnebenereu...	83'006'935	8'223'790
meat mixed, organic, at slaughterhouse	CH	0	kg	1.84E-2	1.24E-1	016.00	1	Fleisch und genießt getrocknet oder gerä...	1'897'149	1'178'393
meat mixed, IP, at slaughterhouse	CH	0	kg	8.34E-2	1.21E-2	017.00	1	Fleisch und genießbare Schlachtnebenereu...	8'597'404	115'009
storage, fresh meat, in cold store	RER	0	kg	8.98E-1	8.64E-1			storage of chilled me		
processing and distribution, meat, conserved	CH	0	kg	1.02E-1	1.36E-1			processing of meat		

average transport

average meat shares

storage & processing

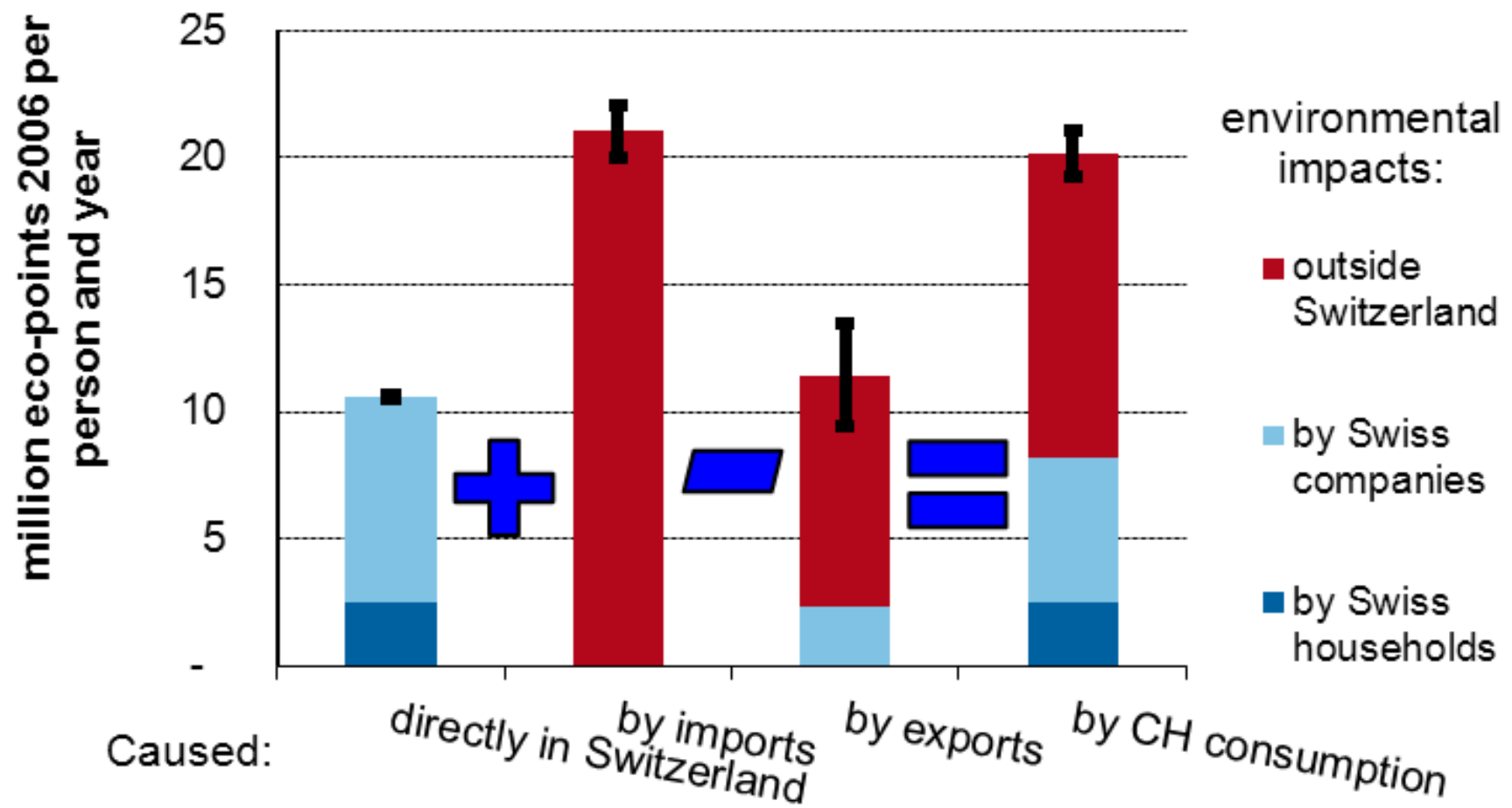
meat import (kg)

meat export (kg)

EcoSpold: Production Sector

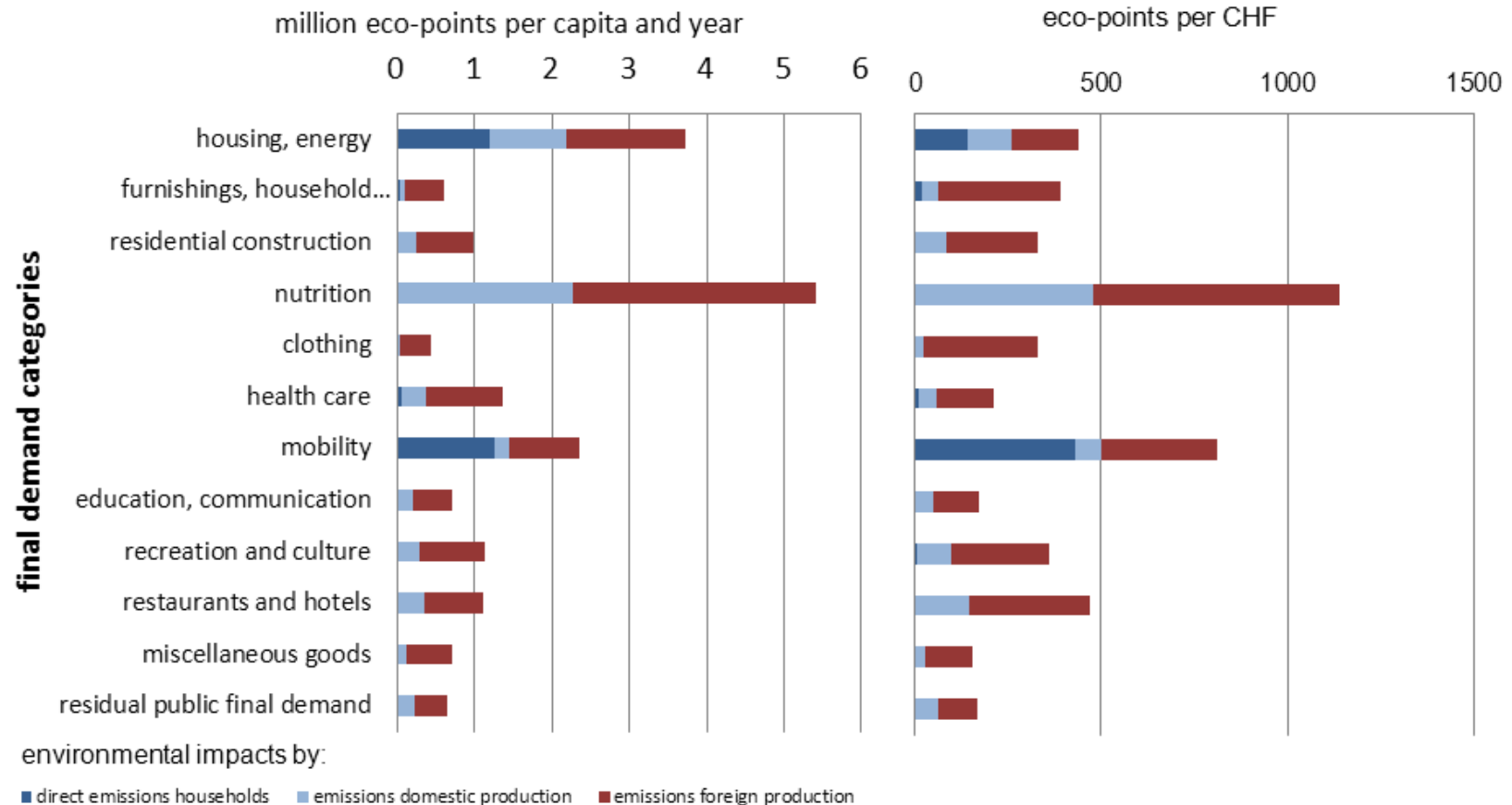
Name	Location	Infrastructure Process	Unit	G01b05, primary sector	Uncertainty type	Standard Deviation 95%	GeneralComment
Location InfrastructureProcess Unit				CH 0 CHF2005			
G01b05, primary sector	CH	0	CHF2005	0.00E+00	1	1.11	(1,1,1,1,1,3); IOT original
G10b14, mining and quarrying	CH	0	CHF2005	4.72E-04	1	1.11	(1,1,1,1,1,3); IOT original
G15b16, food industry	CH	0	CHF2005	6.17E-02	1	1.11	(1,1,1,1,1,3); IOT original
G17, textile	CH	0	CHF2005	1.31E-04	1	1.11	(1,1,1,1,1,3); IOT original
G91b92, recreation, culture and sport	CH	0	CHF2005	1.66E-04	1	1.11	(1,1,1,1,1,3); IOT original
G93b95, private services	CH	0	CHF2005	5.74E-05	1	1.11	(1,1,1,1,1,3); IOT original
Carbon dioxide, in air	-	-	kg	5.45E-01	1	1.22	(4,2,1,1,1,3); BFS (2009); calculated with emissions from primary sector,
Carbon dioxide, fossil	-	-	kg	7.26E-02	1	1.07	(1,1,1,1,1,3); BFS (2009) (NAMEA-air for 2005), carbon monoxide and carbon dioxide in stratosphere subtracted
Carbon dioxide, biogenic	-	-	kg	1.60E-02	1	1.07	(1,1,1,1,1,3); BFS (2009) (NAMEA-air for 2005)
Dinitrogen monoxide	-	-	kg	7.33E-04	1	1.50	(1,1,1,1,1,3); BFS (2009) (NAMEA-air for 2005)
Methane, biogenic	-	-	kg	1.20E-02	1	1.50	(1,1,1,1,1,3); BFS (2009) (NAMEA-air for 2005)
Sulfur hexafluoride	-	-	kg	1.15E-09	1	1.50	(1,1,1,1,1,3); BFS (2009) (NAMEA-air for 2005)
Methane, tetrafluoro-, R-14	-	-	kg	2.51E-09	1	1.50	(1,1,1,1,1,3); BFS (2009) (NAMEA-air for 2005)
Ethane, 1,1,1,2-tetrafluoro-, HFC-134a	-	-	kg	1.69E-06	1	1.50	(1,1,1,1,1,3); BFS (2009) (NAMEA-air for 2005)
Gravel, in ground	-	-	kg	0.00E+00	1	1.09	(2,1,1,1,1,3); BUWAL (2003c)
SITC-00, live animals other than animals of division 03, import	CH	-	kg	6.78E-05	1	1.55	(2,3,1,5,4,3); foreign trade statistic for import combined with IOT for imported goods and correction factor for residence principle
SITC-97, gold, non-monetary (excluding gold ores and concentrates), import	CH	-	kg	1.05E-09	1	1.55	(2,3,1,5,4,3); foreign trade statistic for import combined with IOT for imported goods and correction factor for residence principle
G50, motor vehicle trade	GLO	-	CHF2005	3.14E-05	1	1.55	(2,3,1,5,4,3); IOT for imported services
G85, health and social work	GLO	-	CHF2005	1.24E-04	1	1.55	(2,3,1,5,4,3); IOT for imported services

Results: Total balance



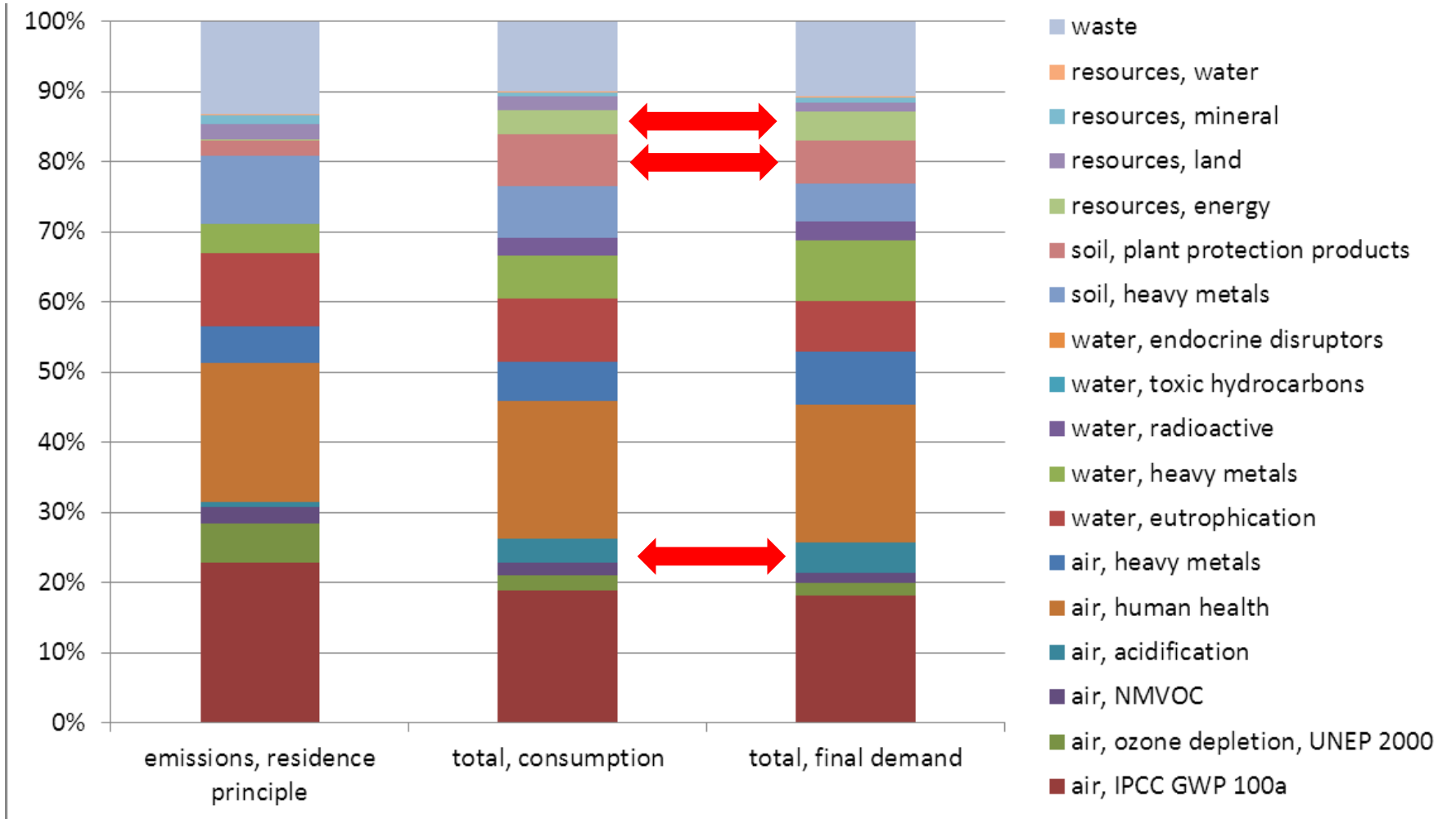
➤ Imports cause 60% of environmental impacts due to Swiss consumption

Consumption perspective



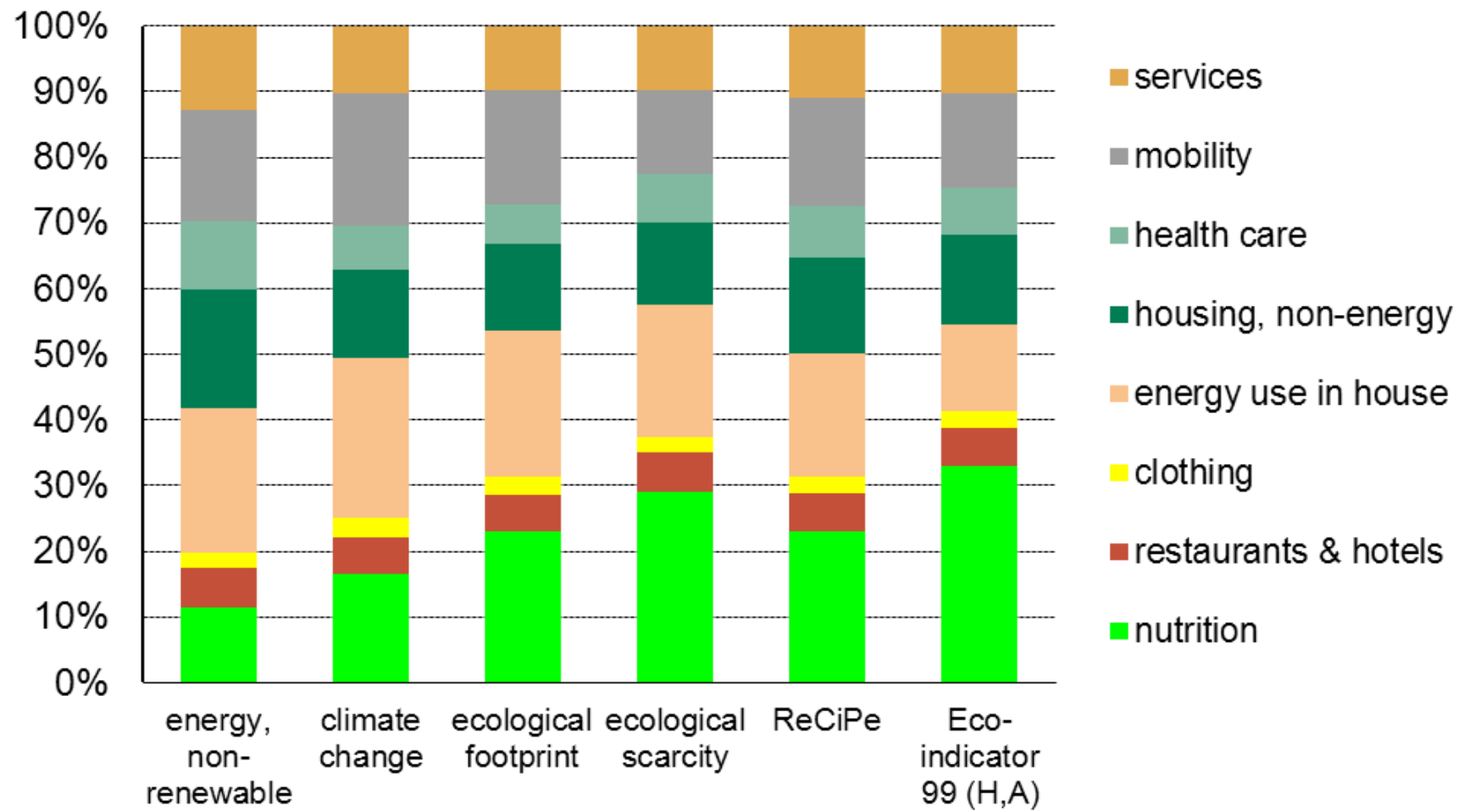
- Nutrition and mobility most intensive per money spent
- 40% of the environmental impacts due to nutrition occur abroad

Importance of emissions



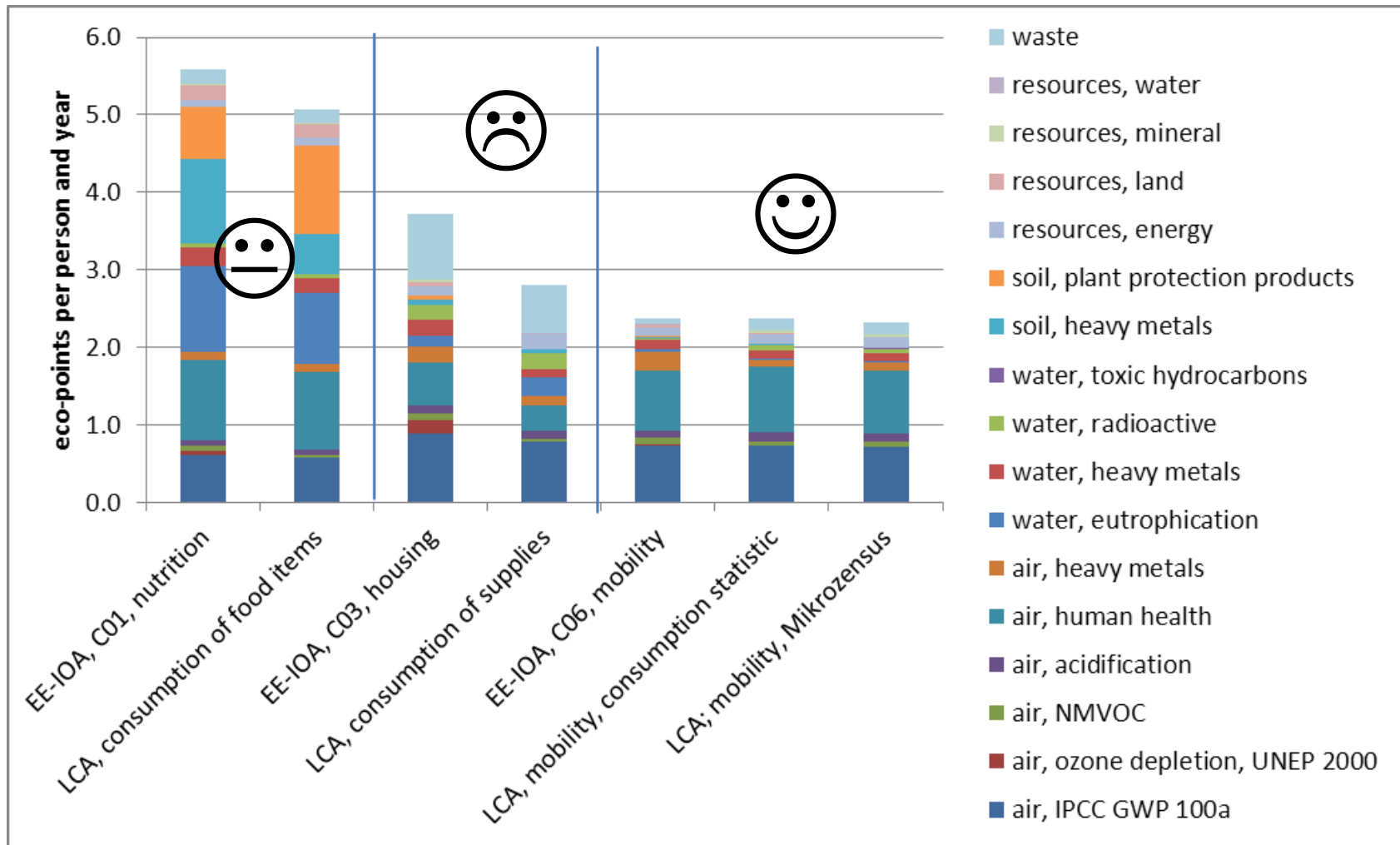
➤ Imports responsible for e.g energy, PPP, acidification

Different indicators on household consumption



➤ Energy and GHG indicators underestimate the contribution of nutrition

Verification by comparison with LCA data



➤ Helps to identify shortcomings and differences in LCA and EE-IOA

Uncertainties and data quality

- Estimated uncertainties in the range of 20-30% (similar to LCI)
- Final results calculated with about 50'000 datapoints provide stability even if single entries are wrong
- Several sources of uncertainty, e.g. combination of different methods, gaps in statistics and simplification
- The presented results have been cross checked with alternative approaches and other publications

➤ Main conclusions are considered to be reliable

Important Differences LCA versus IOT

	EE-IOA	LCA / LCI
Time horizon	One year of consumption and production	Integration of past, present and future emissions
Reference units	Monetary value of products, excluding taxes (Swiss Francs)	Physical flows e.g. kg, MJ, m3
System boundaries	In principle all inputs and outputs in one year are considered.	Cut-off criteria for flows, which are considered minor or which are difficult to investigate. E.g. business travel or research often not included.
Investment goods	Demand in the reference year and not for past provision or future use. Kept separately from production.	Investment goods are depreciated over life time to the production volume in this time.
Stocks of goods	Production of stocks of goods not sold in the particular time horizon is considered separately.	It is assumed that products produced by a company enter the market immediately.
Disposal services	Only included in the reference years. Not including disposal if stocks and infrastructure are built up.	Included. Future or past disposal assumed to be the same as today.
Allocation principle	Allocation by the value of single products. No subdivision going deeper than the sectors distinguished.	Different principles are applied. Joint production processes are subdivided to allocate impacts to single products.
Sectors and products covered	All economic sectors and thus all products are investigated.	Focus on products and services with high environmental relevance and/or large production volumes. Less knowledge on consumer products and services

Content related conclusions

- Environmental relevance of areas of consumption and categories of goods is shown
 - food purchases cause about 30% of the overall environmental impacts
- environmental intensity (ecopoints/CHF) of areas of consumption and categories of goods evaluated
 - food and waste management shows highest values
- Importance of imports: about 60% of the environmental impacts

Key figures per capita and year

- 12.8 Tonnes CO₂-eq
- 8300 Watt
- 20 Million eco-points

Methodological achievements

- The assessment considers the **whole life cycle** and is not restricted to domestic impacts
- This is necessary for Switzerland, because of the importance of **foreign trade**
- **All relevant environmental impacts** in contrast to simplified methods are weighted **transparently**
- The approach allows for an analysis of **production sectors** and **consumption activities**

Outlook

- Ten principal data sources and steps of analysis can be refined with different goals:
 - Better verification of the results in LCA and EE-IOA with alternative approaches
 - Improve the data for 2005 for known shortcomings
 - Update for some years (2005, 2008 and 2011) and follow up of environmental impacts
 - Calculate simplified time series (2nd approach)

Workshop in the afternoon “The Swiss EE-IOA in SimaPro”

- Get an impression of the implementation in EcoSpold format
- Learn how to use the data in SimaPro
- Use evaluations with different LCIA methods
- Tree view for economic activities
- Use of new library in own Hybrid analysis (e.g. skiing)

Further Links

- Download of the study and electronic data
 - www.esu-services.ch/projects/ioa/
- ESU data-on-demand for imported goods
 - www.esu-services.ch/de/daten/datenverkauf/

