



Swiss Centre for Life Cycle Inventories

A joint initiative of the
ETH domain and Swiss
Federal Offices

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agroscope
FAL RECKENHOLZ
Research for Agriculture and Nature



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Comparison of three approaches how to deal with cumulative LCI data in a unit process database

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Challenges



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- Quality guidelines for ecoinvent require
 - Full transparency (at least for data generator)
 - Data on a unit process basis (at least for data generator)
 - Full range of elementary flows
 - Full linkage to background data
 - Standardized assumptions on infrastructure, transports, waste models, allocation, etc.
- Problems with inventory data published in a cumulative format
 - Important modelling questions cannot be harmonized
 - No possibility to use standard background data, e.g. for transports, electricity use
 - No update in case of new developments, e.g. emission control for lorries

The logo for ETH (Eidgenössische Technische Hochschule), consisting of the letters "ETH" in a bold, italicized, sans-serif font.

The logo for EPFL (École Polytechnique Fédérale de Lausanne), consisting of the letters "EPFL" in a white, sans-serif font inside a red rectangle.

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Product system of epoxy resin

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Production of
liquid epoxy resins

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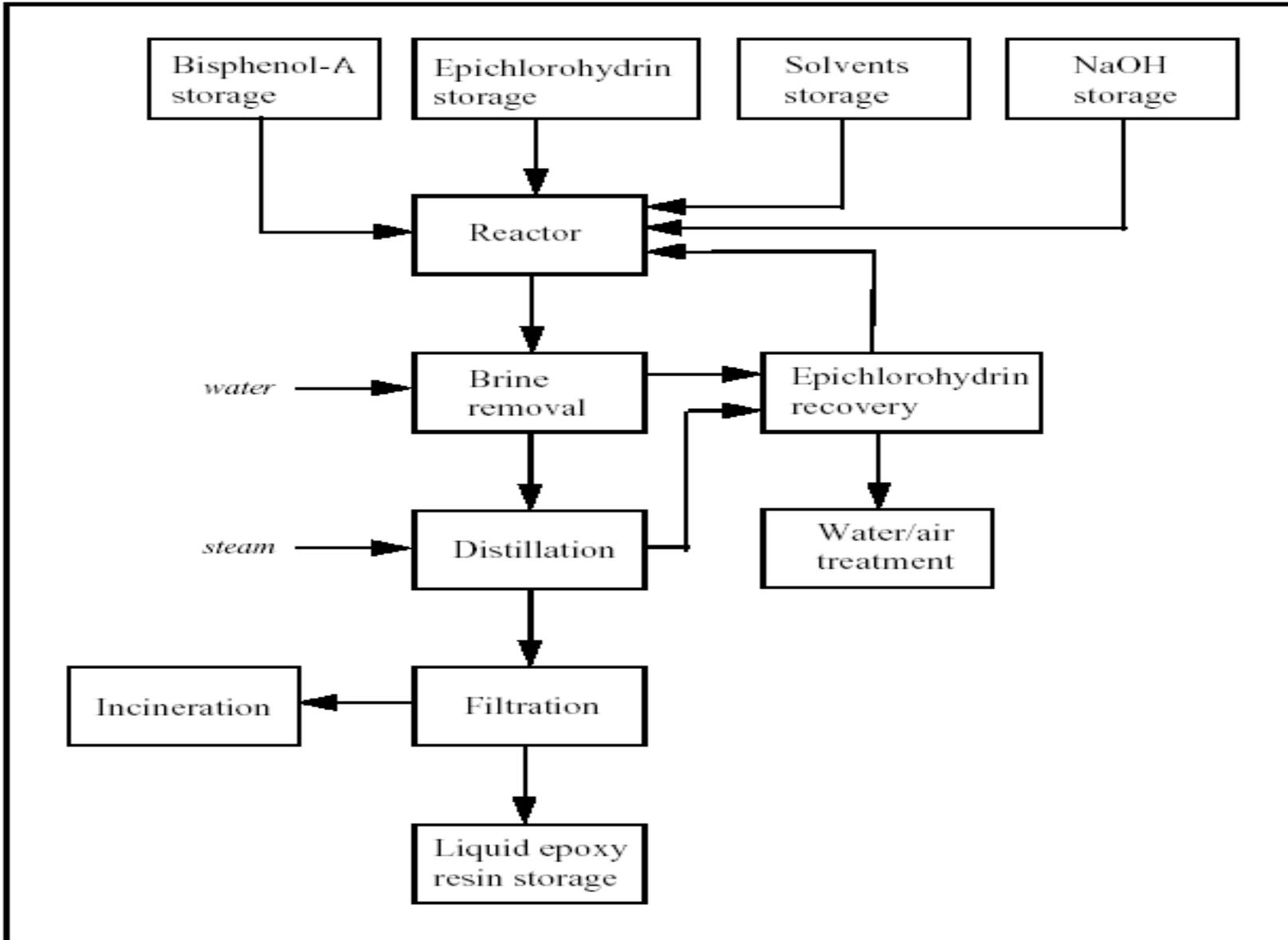
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Missing process data



Example APME data

(APME - Association of Plastics Manufacturers in Europe)



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Selected gross air emissions in mg arising from the production of
1kg liquid epoxy resin

Emission (mg/kg)	Fuel production	Fuel use	Transport	Process operation
Dust	5'500	2'800	21	7'100
CO ₂	1'600'000	3'600'000	34'000	650'000
N ₂ O	<1	<1	-	-

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The logo for PPF (Plastics Processors Federation), consisting of the letters "PPF" in a bold sans-serif font with a red horizontal bar above the letters.

The logo for PSI (Paul Scherrer Institute), consisting of the letters "PSI" in a bold sans-serif font with a horizontal bar through the middle.

The logo for EMPA (Empirean Materials Production Agency), consisting of a red shield-like shape with a white cross and the letters "EMPA" in a bold sans-serif font.

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First approach (1): cumulative data



Name	Location	Infrastructure	Process	Unit	Location	Infrastr	Unit	
								<i>epoxy resin, liquid, at plant</i>
								<i>RER</i>
								<i>0</i>
								<i>kg</i>
disposal, hard coal mining waste tailings, in surface backfill	GLO	0	kg	3.00E-1				
Oil, crude, in ground	-	-	kg	6.70E-1				
Carbon dioxide, fossil	-	-	kg	5.90E+0				
Dinitrogen monoxide	-	-	kg	5.00E-7				

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(...)

- All data are directly taken from the APME publication
- Data “<1” estimated with 0.5
- Only “wastes to disposal” linked to background processes on waste treatment
- No uncertainty ranges



Second approach (2): disaggregated data



Name	Location	Infrastructure	Process	Unit	Location	Infrastr	Unit	Value
electricity, medium voltage, production UCTE, at grid	UCTE	0	kWh	2.19E+0				
heavy fuel oil, burned in power plant	RER	0	MJ	1.10E+1				
disposal, municipal solid waste, 22.9% water, to sanitary landfill	CH	0	kg	2.98E-1				
transport, lorry 32t	RER	0	tkm	6.06E+1				
Carbon dioxide, fossil	-	-	kg	6.50E-1				

epoxy resin, liquid,
disaggregated data, at plant
RER
0
kg

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(...)

- Linkage of data to background processes (e.g. fuel oil energy supply)
- Disposal of process specific wastes linked to background processes
- Process specific emissions from publication, other emissions from database
- Own assumptions on infrastructure and transports according to ecoinvent guidelines
- No uncertainty ranges



Third approach (3): stoichiometric calculation



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bisphenol A, powder, at plant	epichlorhydrin, at plant	sodium hydroxide, 50% in H ₂ O, production mix, at plant
RER	RER	RER
kg	kg	kg
0.83	0.33	0.14

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The logo for PSI (Paul Scherrer Institut), featuring the letters "PSI" in a stylized font with a grey background.

The logo for EMPA (Empirech Materials Processing and Analysis), featuring a red cube icon and the letters "EMPA".

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- Use of 3 pre-products in the stoichiometric ratio
- No process specific data for: yield, emissions, energy uses, infrastructure, process wastes, etc.
- Uncertainty is assessed

Inventory Results (excerpt)

		1	2	3
	Unit	aggregated kg	disaggregated kg	stoichiometric kg
cumulative energy demand	MJ-Eq	125.0	290.0	125.9
Land occupation	m2a	0.003	0.168	0.053
Carbon dioxide, fossil	kg	5.92	15.63	4.26
Nitrogen oxides	kg	0.035	0.093	0.013

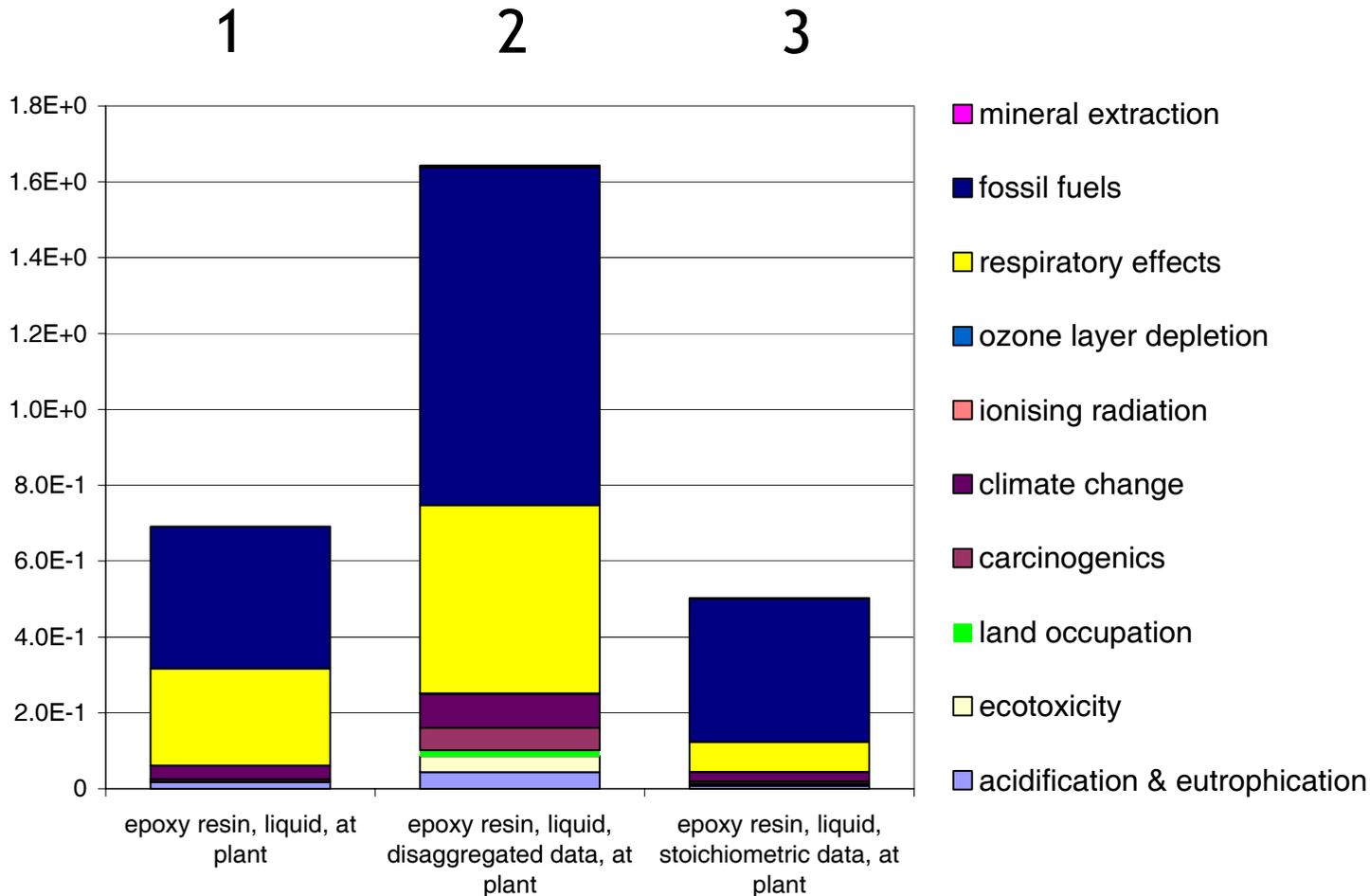
- Cumulative fossil energy use and CO₂ emissions much higher for disaggregated data
=> Lower transport distances seem to be used by APME
- Land use is much lower for aggregated data
=> Only from waste disposal, but no direct land use data in APME
- NO_x emissions higher for disaggregated data
=> Emissions from transport and differing assumptions for combustion?
=> For stoichiometric calculated emissions are sometimes higher, energy is similar

Impact Assessment (EI'99 H,A)



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➤ Main difference: Energy use, respiratory effects (NOx)

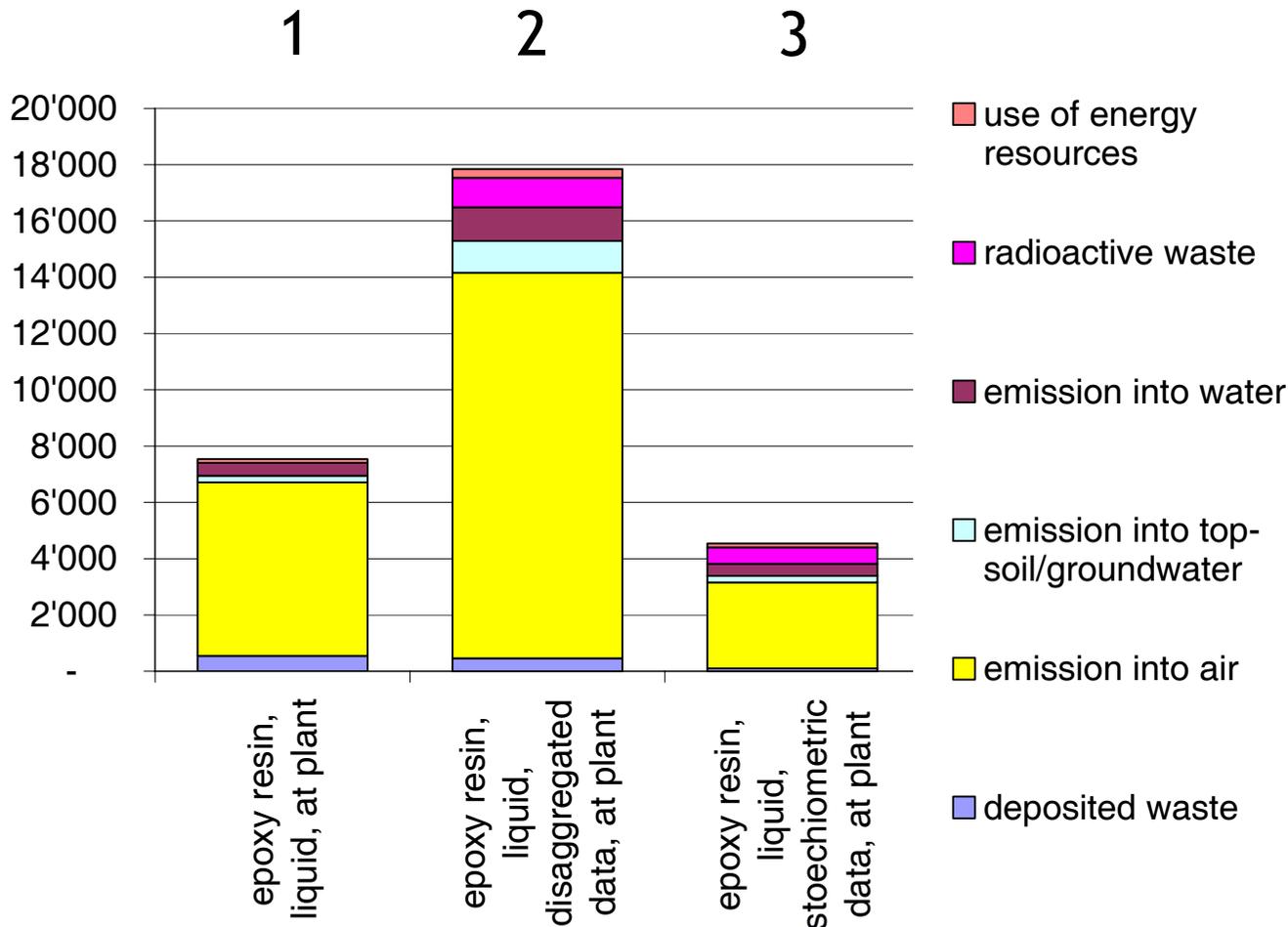


Impact Assessment (ecological scarcity 97)



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➤ Main difference: NOx emissions, radioactive waste



Summary

- **No perfect solution possible for the integration of cumulative data**
- In cumulative data certain aspects may be underestimated, neglected or inconsistent with unit process data
- Disaggregated data get a poor quality rating because important aspects like type of combustion, transport device, etc. are not known, assumptions might be inconsistent
- Stoichiometric data may miss important direct process impacts



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Research for Agriculture and Nature

- ecoinvent Database uses the original cumulative data (first approach)
- It is recommended to use these as background data but not for comparison with materials investigated in detail

Outlook



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- Industrial data and averages are an important and necessary part of LCI databases
- Ideally, industrial data are supplied to database operators on a unit process basis
- If necessary, confidentiality can be ensured by database operator
- Horizontal industry averages on a unit process basis are no problem
- Vertical accumulation decreases data usability and comparability and thus data quality of further LCA studies
- A good example for industrial databases is e.g. the LCI report on Aluminium published by the European Aluminium Association

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