Special LCA forum, December 5, 2003
ETH Lausanne / Plenary session

Ecoinvent Database Methodology

Rolf Frischknecht, project manager
ecoinvent Administrators

Swiss Centre for Life Cycle Inventories

frischknecht@ecoinvent.ch

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Synopsis

- Data format and Data collection
- Applied Methodology (selected topics)
- Implementation impact assessment methods
- Access to ecoinvent database
- Results
- Perspectives

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EcoSpold: ecoinvent Data format

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- Initially derived from SPOLD 97/99
- Adapted to ISO/Technical Specification 14048
- Enables
  - extensive documentation
  - individual determination of allocation factors
  - confidential data management (if required)
- Data format used for
  - LCI raw data,
  - LCI results,
  - LCIA results, and
  - LCIA methods (characterisation / damage factors).

EcoSpold: Structure

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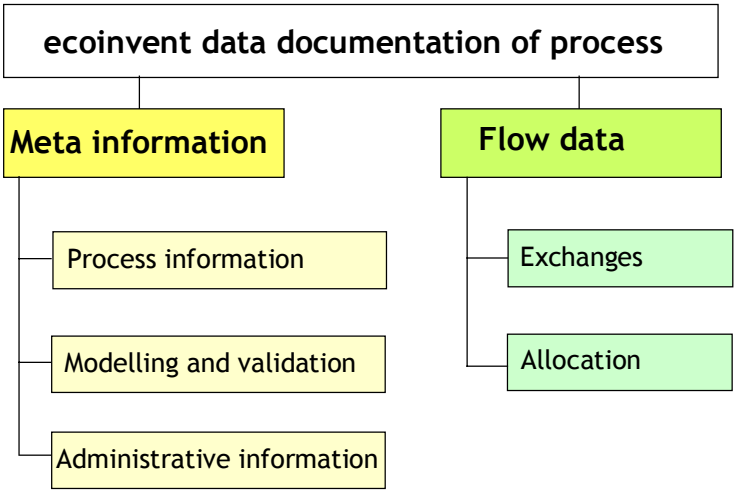

EcoSpold Sections: requirements

Area	Unit proc.	Results	Elem. flows	Impact ass.
ReferenceFunction	Always	Always	Always	Always
Geography	Always	Always	Never	Never
Technology	Always	Possible	Never	Never
TimePeriod	Always	Always	Never	Possible
DataSetInformation	Always	Always	Always	Always
Representativeness	Possible	Possible	Never	Never
Sources	Always	Always	Never	Always
Validations	Possible	Possible	Possible	Possible
DataEntryBy	Always	Always	Possible	Always
DataGeneratorAndPublication	Always	Always	Never	Always
Persons	Always	Always	Possible	Always
Exchanges	Always	Always	Never	Always
Allocations	Possible	Never	Never	Never

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Names Processes / Products

Name includes (fixed sequence):

- Name of product / service
- Additional properties
- Level of value chain
- Any further detail

Examples:

Name (ID 401)	Location (ID662)	Infrastruc-tureProcess (ID 493)	Unit (ID 403)
ammonia, steam reforming, liquid, at plant	RER	no	kg
heavy fuel oil, at regional storage	RER	no	kg
anhydrite synthetic, at plant	CH	no	kg
electricity, medium voltage, production CH, at grid	CH	no	kWh
hard coal, at regional storage	ZA	no	kg
transport, lorry 32t	RER	no	tkm
disposal, refinery sludge, 89.5% water, to hazardous waste incineration	CH	no	kg
refinery	RER	yes	unit

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Elementary flows

- Names derived from the list published by SETAC AG „Data Quality and Data Availability"
- category = compartment (air, water, soil, resource)
- subcategory = differenciation within the compartments
  e.g. air:
  - high population density („Stadt")
  - low population density („Land")
  - lower stratosphere / upper troposphere (airplanes)
  - unspecified

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Elementary flows, long-term emissions

- „short-term" emissions: <100 years
- „long-term" emissions (mainly from landfill sites) recorded separately
- Time horizon:
  60'000 years for landfill sites
  80'000 years for Radon-222 emissions from Uranium extraction and milling
- Separate subcategory „long-term" for:
  - air / low population density
  - water / ground-
  - water / river-

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Procedure data collection

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- Data delivered as unit process raw data (exception APME plastics data)
- Connected to product systems in the ecoinvent database
  -> maximum transparency,
  -> maximum consistency,
  -> maximum flexibility (punctual updates, if necessary),
  -> maximum co-ordination effort.
- More than 2'500 unit processes = more than 2'500 product systems !

Procedure data collection

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		Transport by Crude Oil Carrier	Heavy Fuel Oil from Refinery
	unit	tkm	t
Requirements & Product:			
Transport by Crude Oil Carrier	tkm	1	-10'000
Heavy Fuel Oil from Refinery	t	-1.80E-06	1
Emissions:			
CO2, Carbon dioxide	g	5.5	180000
SOX, Sulphur oxides	g	0.13	1000
NMVOC	g	8.30E-04	500

Methodology (selected topics)

- Land use
- Uncertainties
- Allocation
- Miscellaneous

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Land use aspects

Basis for recording land use in ecoinvent LCIs:
results of the LCA discussion forum No. 14 (Sept. 2001)

For assessing the direct influence on ecosystems due to land use, a distinction is made between

- **Land transformation**
  e.g., transformation from agricultural land to roads
- **Land occupation**
  e.g., a certain surface is used as a road

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Land occupation

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- Size of the surface
- Duration of use
- Amount of products / services manufactured
- Land quality during the use (CORINE classes)
  e.g., road, industrial area, agricultural land, etc.

Land occupation recorded as m^2 times year (m^2a)

example:

0.3 m^2a "occupation, mineral extraction site" (CORINE 131) per kg gravel

Land transformation

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Two transformation steps recorded separately:

- Transformation from state A
- Transformation to state B

Required information:

- Size of the surface & land cover type
- Amount of products / services manufactured
- Default use periods, e.g.:
  - Industrial area: 50a
  - roads, dams: 100a
  - agricultural surfaces (grain, vegetables): 1a
  - agricultural surfaces (permanent crops): 20-30a

Example (fictive): gravel extraction

- Total surface: 10'000m^2
- Use period: 20 years
- Amount of gravel extracted: 1'000 tons per year
- Active Restoration to forest
- Diesel consumption for extraction and restoration: 200'000MJ per year (= 200 MJ per ton)

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Example gravel extraction

			gravel, crushed, at mine t
resource, land	occupation, mineral extraction site	m^{2}a	10
	occupation construction site	m^{2}a	
	transformation, from unknown	m^2	0.5
	transformation, to mineral extraction site	**m2**	**0.5**
	transformation, from mineral extraction site	**m2**	**0.5**
	transformation, to forest	m^2	0.5
resource, in ground	gravel, in ground	t	1
Technosphere input	diesel, burned in building machine	MJ	200
	diesel, burned in building machine	MJ	200
	...	...	
Reference product	gravel, crushed at mine	t	1

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Uncertainties

- uncertainty distribution and max/min-values recorded for each input/output of a unit process
- default: lognormal distribution (applied in all datasets)
- Where uncertainty information was not available: Pedigree-approach (derived from Weidema & Wesnaes '96):
  - reliability,
  - completeness,
  - temporal correlation,
  - geographical correlation,
  - technical correlation,
  - sample size.

  + basic uncertainty for pollutants and inputs

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Criteria Pedigree-Matrix

- Temporal correlation (relative to year 2000):
  1: less than 3 years,
  2: less than 6 years,
  3: less than 10 years,
  4: less than 15 years,
  5: more than 15 years or age unknown.
- Geographical correlation: data from
  1: identical region (e.g. danish data for danish processes),
  2: larger region (e.g. Western Europe instead of Sweden),
  3: smaller or similar region,
  5: unknown or distinctly different region.
  (e.g. North America instead of Middle East)

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Pedigree-approach: Uncertainty factors for indicators

Indicator value	1	2	3	4	5
Reliability	1.00	1.05	1.10	1.20	1.50
Completeness	1.00	1.02	1.05	1.10	1.20
Temporal correlation	1.00	1.03	1.10	1.20	1.50
Geographical correlation	1.00	1.01	1.02		1.10
Further technical correlation	1.00		1.20	1.50	2.00
Sample size	1.00	1.02	1.05	1.10	1.20
Total uncertainty of one pedigree score	**1.00**	**1.07**	**1.27**	**1.65**	**2.56**

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Pedigree-approach: Uncertainty factors for Inputs/Outputs

Basic uncertainty	
Energy demand [MJ, kWh]	1.05
Transport services [tkm]	2.00
Infrastructure [unit]	3.00
Carbon dioxide in air	1.05
PM2.5 from combustion	3.00
Heavy metals in water	5.00
Radionuclides in water	3.00

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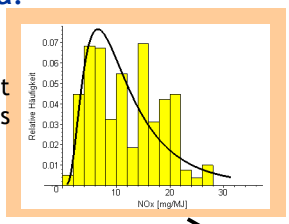
Monte Carlo-Simulation

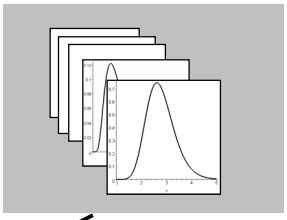
Input data:

Emissions boiler

Fuel supply chain

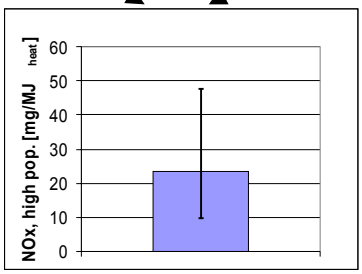
direct NO_X-emissions





Results:

cumulative NOx-emissions



Monte-Carlo-simulation

← Max (97.5%)

← Min (2.5%)

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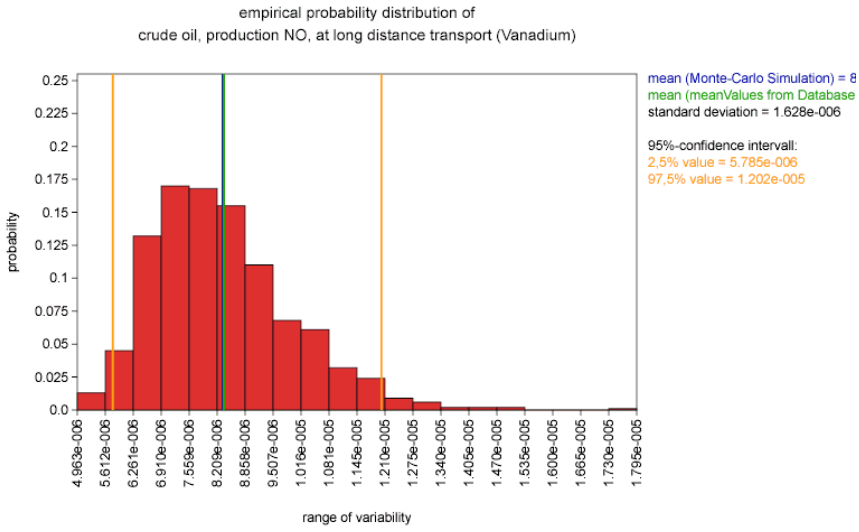
Credits: PSI

Uncertainties: First assessments in ecoinvent



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Allocation

- Multi-output processes are stored in the database – BEFORE allocation
- Input- and output-specific allocation factors, i.e. individual allocation factor allowed per pollutant and input
- Allocation executed after import of dataset into database
  -> calculation of allocated unit processes
  -> matrix becomes invertible
- NO System expansion,
  NO credits
- Cut-off applied for outputs without economic value and wastes for recycling

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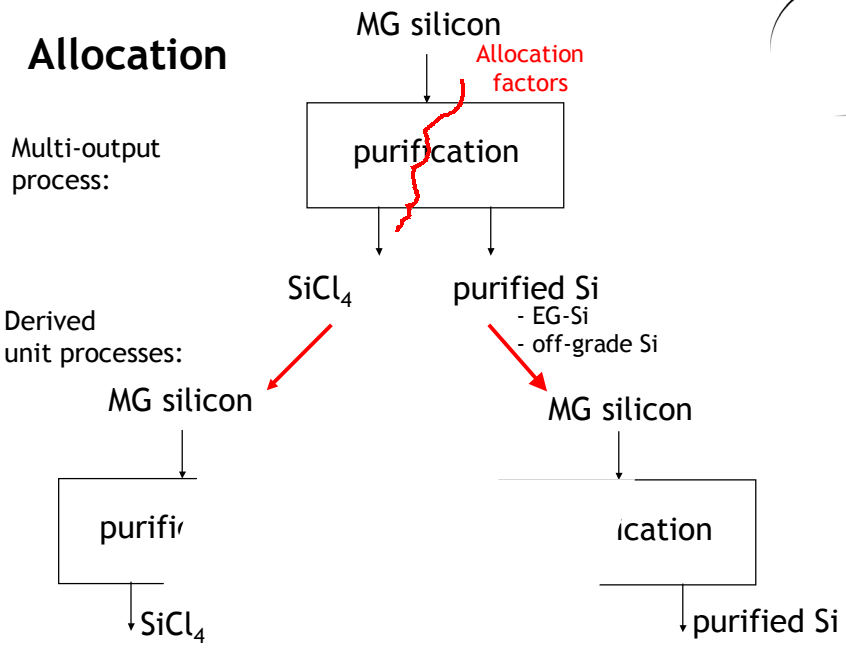
Allocation



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Multi-output process raw data BEFORE allocation

Multi-output process inputs/outputs before allocation

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	Name	Location	Unit	MG-Si in purif.	EG-Si	Off-grade Si	$SiCl_4$	Allocation criteria
	Location							
	Unit			kg	kg	kg	kg	
allocated products	silicon, electronic grade, at plant	DE	kg	6.76E-1	100	0	0	
	silicon, electronic grade, off-grade, at plant	DE	kg	8.44E-2	0	100	0	
	silicon tetrachloride, at plant	DE	kg	1.20E+0	0	0	100	
technosphere	MG-silicon, at plant	NO	kg	1.00E+0	71.1	8.9	20.0	Material balance
	polyethylene, HDPE, granulate, at plant	RER	kg	6.37E-4	72.0	2.4	25.6	Revenue all products
	hydrochloric acid, 30% in H2O, at plant	RER	kg	2.00E+0	48.4	1.6	50.0	Stoechometric calculation
	natural gas, burned in boiler condensing modulating >100kW	RER	MJ	1.22E+2	96.8	3.2	-	Revenue purified silicon
	electricity, natural gas, at combined cycle plant, best	RER	kWh	8.66E+1	96.8	3.2	-	Revenue purified silicon
	electricity, hydropower, at run-of-river power plant	RER	kWh	2.74E+1	96.8	3.2	-	Revenue purified silicon
	price	GLO	€	70.36	75.00	20.00	15.00	
	revenue	GLO	€	70.36	50.67	1.69	18.00	

Allocation factors (in %)

Unit process raw data AFTER allocation

derived unit process inputs/outputs

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	Name	Location	Unit	MG-silicon, to purification	EG-Si	Off-grade Si	$SiCl_4$	
	Unit	0	0	kg	kg	kg	kg	
allocated products	silicon, electronic grade, at plant	DE	kg		1	0	0	
	silicon, electronic grade, off-grade, at plant	DE	kg		0	1	0	
	silicon tetrachloride, at plant	DE	kg		0	0	1	
technosphere	MG-silicon, at plant	NO	kg		1.1	1.1	0.2	Material balance
	polyethylene, HDPE, granulate, at plant	RER	kg		6.79E-4	1.81E-4	1.36E-4	Revenue all products
	hydrochloric acid, 30% in H2O, at plant	RER	kg		1.4	0.4	0.8	Stoechometric calculation
	natural gas, burned in boiler condensing modulating >100kW	RER	MJ		174.2	46.5	-	Revenue purified silicon
	electricity, natural gas, at combined cycle plant, best	RER	kWh		124.1	33.1	-	Revenue purified silicon
	electricity, hydropower, at run-of-river power plant	RER	kWh		39.2	10.5	-	Revenue purified silicon

Infrastructure requirements

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- Infrastructure requirements modelled consequently
- Infrastructure usually modelled as „units", i.e.
  1 chemical plant,
  1 refinery,
  1 airport,
- Often rough estimations, jointly used datasets
- Minimum requirement for infrastructure datasets:
  land transformation and occupation

Modelling electricity mixes

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- Electricity trade included
- Voltage level considered

Electricity consumption in	Electricity mix applied
from self producer	Inhouse-power plant (mix)
a specific industry branch	mix of industry branch
Great Britain	GB mix including trade
a european country	europ. country's mix including trade
Western Europe	UCTE
Eastern Europe	CENTREL
Northern Europe	NORDEL
Europa	UCTE
North America	UCTE
Asia	UCTE
anywhere	UCTE

Implementation LCIA methods

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- No method development within the ecoinvent 2000 project; implementation of existing methods
- Objective:
  unified application of LCIA methods on ecoinvent LCI data
- Implemented in ecoinvent data v1.01:
  - Cumulative energy demand (CED),
  - Climate change (according to IPCC 2001),
  - Ecological scarcity method 1997
  - Eco-indicator 99 (E,E; H,A; I,I)
  - Impact 2002+ (developed by EPFL)
- To be implemented in data v1.1: EDIP, EPS, CML 2001

Implementation LCIA methods

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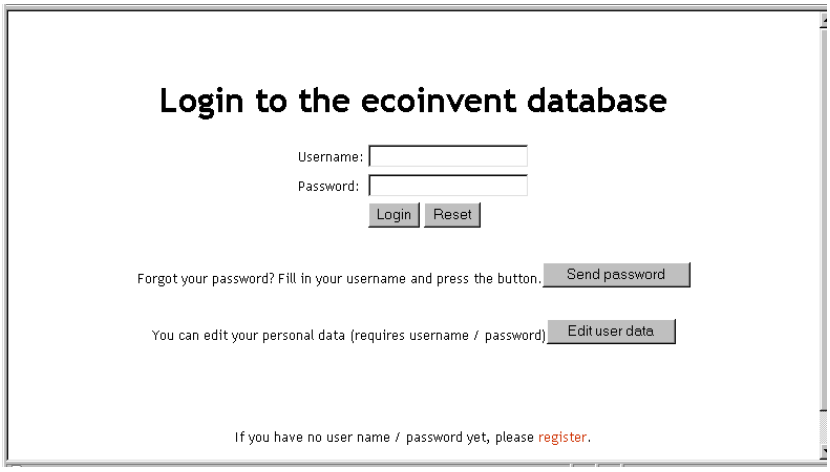
Attribution of factors to LCI results is a real challenge!

- No explicit statements in the methods concerning long-term emissions and subcompartments
  -> lively and controversial discussions
- Examples of attributions made in ecoinvent data v1.0:
  - factors „unspecified" applied on ALL subcompartments,
  - long-term emissions are included in weighting, if not explicitely excluded by the method (e.g., ei'99, individualist),
  - no extrapolation of factors to „similar" substances,
  - factors for sum parameters are applied on individual species.

Access to ecoinvent database



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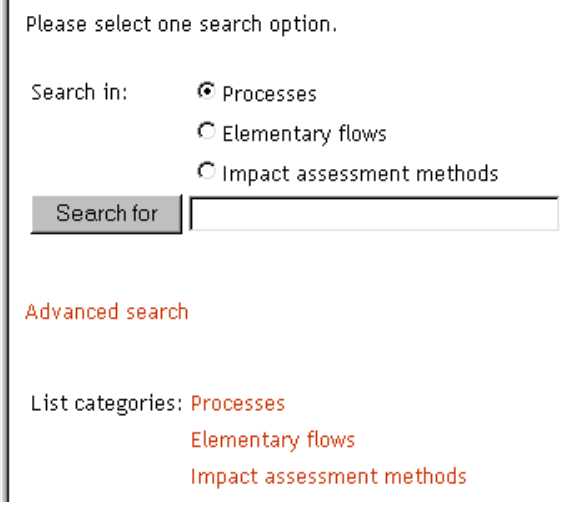
Search



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Categories for processes

Clicking a category leads to a list of the subcategories.

1 agricultural means of production	13 heat pumps	25 photovoltaic
2 agricultural production	14 hydro power	26 plastics
3 biomass	15 insulation materials	27 private consumption
4 chemicals	16 lignite	28 solar collector systems
5 construction materials	17 metals	29 transport systems
6 construction processes	18 mortar and plaster	30 washing agents
7 cooling	19 natural gas	31 waste management
8 district heating	20 nuclear power	32 water supply
9 electricity	21 oil	33 wind power
10 food industry	22 others	34 wood energy
11 glass	23 paintings	35 wooden materials
12 hard coal	24 paper & cardboard	

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Advanced search

Here you can limit search results in a detailed way. You find help on the search here.

Search in: (•) Processes ( ) Elementary flows ( ) Impact assessment methods

Dataset name: [ ]

[ ] Case-sensitive

CAS-number: [ ]

Formula: [ ]

Recorded by: [all]

Category (english): [ ]

Select categories

Subcategory (english): [ ]

Select subcategories

Sort results: ( ) by name (•) by category

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Select datasets

Processes found

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Your search brought the following results:

6 processes were found.

	no.	category / subcategory	datasetname	location	unit	infra.	synonyms
☐	1	chemicals / inorganics	magnesium oxide, at plant	RER	kg	No	-
☐	2	chemicals / inorganics	magnesium sulphate, at plant	RER	kg	No	-
☐	3	metals / extraction	magnesium plant	RER	unit	No	-
☐	4	metals / extraction	magnesium, at plant	RER	kg	No	-
☐	5	metals / extraction	magnesium-alloy, AZ91, at plant	RER	kg	No	-
☐	6	metals / extraction	magnesium-alloy, AZ91, diecasting, at plant	RER	kg	No	-

Add marked | Add all displayed | Remove all displayed

Selection dataset content

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Content EcoSpold-Files

Please define the content of the EcoSpold-files.
Properties for generated processdata:

Infrastructure	LCI data	Impact assessment
◉ With	◉ LCI results	○ With
○ Without	○ unit process raw data	◉ Without
○ Both	○ Both	○ Both

XML-File

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       Energiesystemen; Grundlagen für den ökologischen Vergleich von Energiesystemen und den Einbezug von
       Energiesystemen in Ökobilanzen für die Schweiz" placeOfPublications="Bern, CH" publisher="Bundesamt für
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```

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How to work with ecoinvent data

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- Download of individual datasets (max. 5 at once)
- Convert with EcoSpold-Software to Excel (EcoSpold Software available on www.ecoinvent.ch)
- Perform LCAs in Excel

OR (strongly recommended)

- commercial LCA Software tool, that include ecoinvent data v1.0 (like Emis, GaBi, KCL, PEMS, Regis, SimaPro, Team, Umberto)
- During the Apéro:
  -> presentation of LCA software
  -> online presentation of ecoinvent database

Comparison of results ecoinvent data v1.0 vs. LCI energy systems 1996

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Differences LCIA-results ecoinvent v1.0 vs. ETHZ/PSI`96

Energy	UBP'97	EI'99 (H,A)	GWP 100a
electricity CH	18.0%	-16.8%	-9.9%
electricity UCTE	3.9%	-11.5%	-9.1%
light fuel oil	-16.0%	3.1%	-0.9%
petrol	-23.5%	-1.4%	-17.5%
natural gas	-23.4%	-4.0%	-33.8%
hard coal	-1.0%	-42.9%	2.1%

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Differences LCIA-results ecoinvent v1.0 vs. ETHZ/PSI`96

Materials	UBP'97	EI'99 (H,A)	GWP 100a
steel low alloyed	74.7%	84.1%	-39.5%
concrete	152.3%	343.0%	-11.1%
copper	56.5%	97.2%	-70.1%
platinum	18.6%	23.1%	9.3%
chlorine	29.8%	22.7%	8.2%
organic chemicals	-16.7%	126.1%	-8.5%

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Trends

- Scores of energy supply systems tend to be lower
- Scores of material extraction and supply tend to be higher
  -> new in-depth analysis of extraction and refining processes including production wastes
  -> energy related environmental burdens show lower relevance

-> Parallel sessions will go more deeply into selected topics

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ecoinvent co-operations

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- Germany:
  LCI network (Forschungszentrum Karlsruhe)
- USA:
  National LCI Database (G. Norris, Boston)
- EU:
  LCA Database Initiative (T. Rydberg, Europ. Commission, Ispra)
  COST-Action 530, working group Database
- International:
  Life Cycle Initiative (UNEP/SETAC, Paris/Brussels)
- Japan (Contacts to be established):
  LCA database initiatives

Future work

Swiss Centre For Life Cycle Inventories

A joint initiative of the ETH domain and Swiss Federal Offices

- Database system:
  - International harmonisation of Data(exchange)format
  - Inclusion of additional features (e.g. uncertainty information with LCIA methods, Monte Carlo simulation including LCIA)
- Database contents:
  - LCIs of products/services in further economic sectors (e.g. mechanical engineering, electronics, metal ore extraction) and economies (Northern America, Asia)
  - share the LCI work internationally (?)
- Impact assessment methods:
  - explicit consideration of long-term emissions
  - further differentiation of compartments (such as high/low pop. dens.)
- ecoinvent Centre:
  - Consolidation/Extension of scope of the Swiss LCI Centre