2nd International ecoinvent Meeting
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ecoinvent data v2.0
Metals (for ICT): Introduction

Hans-Joerg Althaus, Empa
Session overview

- Introduction
  Hans-Joerg Althaus, Empa

- Modelling Principles and Results
  Mischa Classen, Empa

- Gold and Silver
  Sybille Büscher, ESU-services (→ see separate file !)

- Discussion

Metals in ecoinvent data v2.0

- 204 Datasets, 110 new ones

- 92 “end-user” Datasets, 32 new ones

- Existing Datasets partly updated and refined

→ some relevant changes in LCIA results
Metals in ecoinvent data v2.0

- New data mainly for metals used for ICT

- Most metals produced from coupled resources  
  → complex modelling necessary

- Many metals produced from very low concentrated ores  
  → relevant influence of allocation procedure
metals:

Modelling Principles and Results

Mischa Classen, Empa Dübendorf

Overview

- Objectives and approach for v2.0
- Implementation of LCI-extension
  - Accounting for resource use
  - Co-product allocation
  - Correction for mass balance
- Conclusions
- Overview of valuation results
- Changes of selected indicators with v2.0
Metals in ICT

- Metals play a vital role in consumer products
- Ever more complex materials in increasing pace developed
- Small amounts of expensive materials used
- Challenge of covering the most relevant metals with LCI

Metals in ICT - Uses

- Metals are used in EEE as
  - Bonds and Contacts
    - Silver
    - Gold
    - Copper
    - Platinum Group Metals
  - Semiconductors
    - Silicium
    - Cadmium Telluride (CdTe)
    - Gallium Arsenide (GaAs)
  - Conductive Layers
    - Indium Tin Oxide (ITO)
  - Capacitors
    - Tantalum Powder
Metals in ICT - Sources

- Sources of the identified new metals

Cd
In
Te
Ag
Au
Ta
Ga

Lead / Zinc
Copper
Gold
Tantalum
Aluminium

Metals in ICT - Web of Metals

- Orebodies contain characteristic mix of metals
- Apart from mainproducts:
  - Co-products
  - By-products
  - Inpurities
- Guidance for LCI modelling:
  - Which coproducts?
  - Nature of allocation

Wheel of metals (Reuter, JOM 2004)
Modelling Approach I

**Gallium:** Co-Product of Aluminium extraction

Low economic interest for Alu industry, price determined by purification

- Allocation of upstream burden based on economic criteria → “zero-allocation”
- Allocation of resource based on physical criteria

Treat Resource like Technosphere process
Aluminium Inventory not affected

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Modelling Approach II

**Tellurium:** Co-Product of Copper-extraction, jointly with Silver

Some economic interest for Copper industry (namely Silver)

- Allocation of upstream burden based on economic criteria → Proceeds of the final commodities Tellurium and Silver
- Allocation of resource based on mass

Approximate upstream processes with existing LCI
Modelling Approach II

- Approximate upstream processes with existing LCI

Coupled resources Cu, Mo, Ag, Te

1.002 kg → 1 kg

Cathode Copper → Refining of Cu → “Clone” Copper

Anode Slime

1.63 g

Silver, Tellurium

Copper Inventory not affected

Creation of a “Clone” copper dataset.

Modelling Approach III

Silver, Indium and Cadmium

Pb/Zn = important Source

- Full extension of existing LCIs
  - Adapt elementary flow
  - Co-product ratio
  - Allocation
  - Mass balance correction

Coupled resources, Pb, Zn, Ag, In, Cd

Mining of Pb / Zn

Winning of Pb → Lead

Winning of Zn → Zinc

Indium

Cadmium
Designation of Resource flow

Silver, 0.007% in sulfide, Pb 3.0%, Zn 5.3%, Ag 0.004%, Cd 0.18% , In 0.003%, in crude ore, in ground

- Based on ore concentrations,
  - But: no distinguishable ore type for co-product metals
- Harmonised with LCI model
  - Production ratio of carrier metal and co-product
  - Extraction yield
  - Processing yields
- Concentrations have to rely on back-calculations
  - global production of carrier metal (e.g. Lead) and
  - co-product metal (e.g. Silver)

Production Ratio of Co-product

- Scaled to world wide production, eg. Silver from Lead cycle

- 21% Ag from secondary
- 31% Ag from lead
  - 24% of 20'000 tpa Ag
  - 0.142% of Pb production

Per kg Lead
- 1.42 g refined Silver, or
- 8.1 g Parkes Crust @ 18% Ag
- 1.86 kg ore concentrate @ 0.08% Ag
- 21.5 kg minerals in ore @ 0.007% Ag
- 36.2 kg crude ore @ 0.0043% Ag
Production Ratio of Co-product

- Top down vs. bottom up, eg. Indium from Zinc cycle

Discrepancy:
Avg. grade: 50 ppm
Back-calculated: 19 ppm
50 ppm would mean over the double global output than actually reported
Assumption: not all of the In in the extracted ore is refined.
- 40% of the In-values are dumped with the gangue.

Allocation procedure

- By revenue
  - Cd considered impurity: zero-allocation
  - Split refined commodity vs. Intermediate
    - e.g. Silver from Lead refining

At what price?

<table>
<thead>
<tr>
<th></th>
<th>Silver</th>
<th>Lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$270</td>
<td>$1.2</td>
</tr>
<tr>
<td>Average 2004-2006</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Allocation procedure

- Reasoning
  - Intermediate (Parkes Crust) „for free“
  - Targeted profit at company level: 10%
- What would be the max. price for external purchase?
  = opportunity cost
  → Same as margin,
  → 10 % of proceeds by refined commodities, disregarding subsequent possible process losses

<table>
<thead>
<tr>
<th>Lead / Silver bearing concentrate</th>
<th>Process Yield</th>
<th>lead concentrate</th>
<th>parkes process crust</th>
<th>lead</th>
<th>Value in $ / kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>composition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pb</td>
<td>98.0%</td>
<td>55%</td>
<td>39%</td>
<td>100%</td>
<td>1.15</td>
</tr>
<tr>
<td>Ag</td>
<td>97.4%</td>
<td>0.08%</td>
<td>18%</td>
<td>0%</td>
<td>27</td>
</tr>
<tr>
<td>Amount</td>
<td>kg</td>
<td>1.86</td>
<td>0.0081</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Value contained in $</td>
<td>$</td>
<td></td>
<td>0.04</td>
<td>1.15</td>
<td></td>
</tr>
<tr>
<td>Allocation by Value</td>
<td></td>
<td></td>
<td></td>
<td>3%</td>
<td>97%</td>
</tr>
</tbody>
</table>
Correct Mass Balance of Resource

- Hybrid allocation scheme:
  - Economic for process-emissions and upstream
  - Physical where mass balance required (resource)

<table>
<thead>
<tr>
<th>correction from economic to per mass</th>
<th>according to economic allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resources demand in the feed</td>
<td>Lead</td>
</tr>
<tr>
<td>Concentrate</td>
<td>kg</td>
</tr>
<tr>
<td>Ag</td>
<td>kg</td>
</tr>
<tr>
<td>Ag</td>
<td>kg</td>
</tr>
<tr>
<td>Resources attributed in by-product</td>
<td>according to per mass allocation</td>
</tr>
<tr>
<td>Pb</td>
<td>kg</td>
</tr>
<tr>
<td>Ag</td>
<td>kg</td>
</tr>
<tr>
<td>Resource exchange flow</td>
<td>difference to be corrected</td>
</tr>
<tr>
<td>Pb</td>
<td>kg</td>
</tr>
<tr>
<td>Ag</td>
<td>kg</td>
</tr>
</tbody>
</table>

Correct Mass Balance of Resource

- Representation in ecoinvent

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>RER</th>
<th>Q (MJ)</th>
<th>unit</th>
<th>factor</th>
<th>code</th>
</tr>
</thead>
<tbody>
<tr>
<td>10066</td>
<td>hard coal, burned in industrial furnace 848, 1-10MW</td>
<td>0</td>
<td>6.9118</td>
<td>MJ</td>
<td>lognormal</td>
<td>1.2515</td>
</tr>
<tr>
<td>1100</td>
<td>heavy fuel oil, burned in industrial furnace 1989, 110MWh, 350°C</td>
<td>0</td>
<td>0.28422</td>
<td>MJ</td>
<td>lognormal</td>
<td>1.2515</td>
</tr>
<tr>
<td>1104</td>
<td>iron ore, 62% Fe, at beneficiation</td>
<td>0</td>
<td>0.06372</td>
<td>kg</td>
<td>lognormal</td>
<td>1.2515</td>
</tr>
<tr>
<td>1105</td>
<td>lead concentrate, at beneficiation</td>
<td>0</td>
<td>1.8503</td>
<td>kg</td>
<td>lognormal</td>
<td>1.2297</td>
</tr>
<tr>
<td>10065</td>
<td>resource correction, PbZn, silver, positive</td>
<td>0</td>
<td>0.001515</td>
<td>kg</td>
<td>lognormal</td>
<td>1</td>
</tr>
<tr>
<td>10066</td>
<td>resource correction, PbZn, silver, negative</td>
<td>0</td>
<td>0.001515</td>
<td>kg</td>
<td>lognormal</td>
<td>1</td>
</tr>
<tr>
<td>10067</td>
<td>resource correction, PbZn, lead, positive</td>
<td>0</td>
<td>0.03536</td>
<td>kg</td>
<td>lognormal</td>
<td>1</td>
</tr>
<tr>
<td>10068</td>
<td>resource correction, PbZn, lead, negative</td>
<td>0</td>
<td>0.03536</td>
<td>kg</td>
<td>lognormal</td>
<td>1</td>
</tr>
<tr>
<td>9520</td>
<td>limestone, milled, packed, at plant</td>
<td>0</td>
<td>0.16875</td>
<td>kg</td>
<td>lognormal</td>
<td>1.2515</td>
</tr>
<tr>
<td>9521</td>
<td>natural gas, burned in industrial furnace</td>
<td>0</td>
<td>0.57721</td>
<td>MJ</td>
<td>lognormal</td>
<td>1.2515</td>
</tr>
</tbody>
</table>
Conclusion & Outlook

- Coupled metal resources: integrated LCI model needed
  - Interconnection of primary, by-product and secondary production!
  - Many choices for allocation and system-model → together with stakeholder?
  - Aim: Harmonisation within whole metal sector

Results - Overview

- Indicator results range over five orders of magnitude
Results - Light and ferrous Metals

Results - Precious and speciality M.
Results - Base Metals

Changes with v2.0

Indicator Changes from v1.3 to v2.0, 64 metal datasets

Presentation: Mischa Classen
Changes with v2.0

- Due to
  - Changes in background data
  - Correction of errors
- Generally IPCC higher (5-10%)
- Specifically
  - SXEW Copper plus 10-30%: changed background data?
  - Lead minus 30-80%: introduction of secondary metal
  - EAF steel: minus 15-25%
  - BOF steel:
    • minus 25% Tox (UBP, eco-indicator),
    • plus 20% energy related (IPCC, CED)

Thank you!