

GreenDELTA

sustainability consulting + software

Life Cycle Costing in openLCA 1.5 with ecoinvent 3.2 extended

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Life Cycle Costing in openLCA 1.5 with ecoinvent 3.2 extended

1. LCC, background
2. LCC implementation in openLCA 1.5
3. An example: Life cycle of a chair
4. An example with ecoinvent 3.2: chair, extended

1 Life Cycle Costing, background

Quick background on Life Cycle Costing, or LCC



Source: Thomas Wolf - Eigenes Werk, CC BY-SA 2.5,
<https://commons.wikimedia.org/w/index.php?curid=2553428>

Quick background on Life Cycle Costing, or LCC

- For many long living goods, the purchase price represents only a small share of the overall costs “of ownership”
- E.g. for trains, 90% of costs in operation and maintenance
- Cost considerations are also relevant in a sustainability context (TBL,etc..)

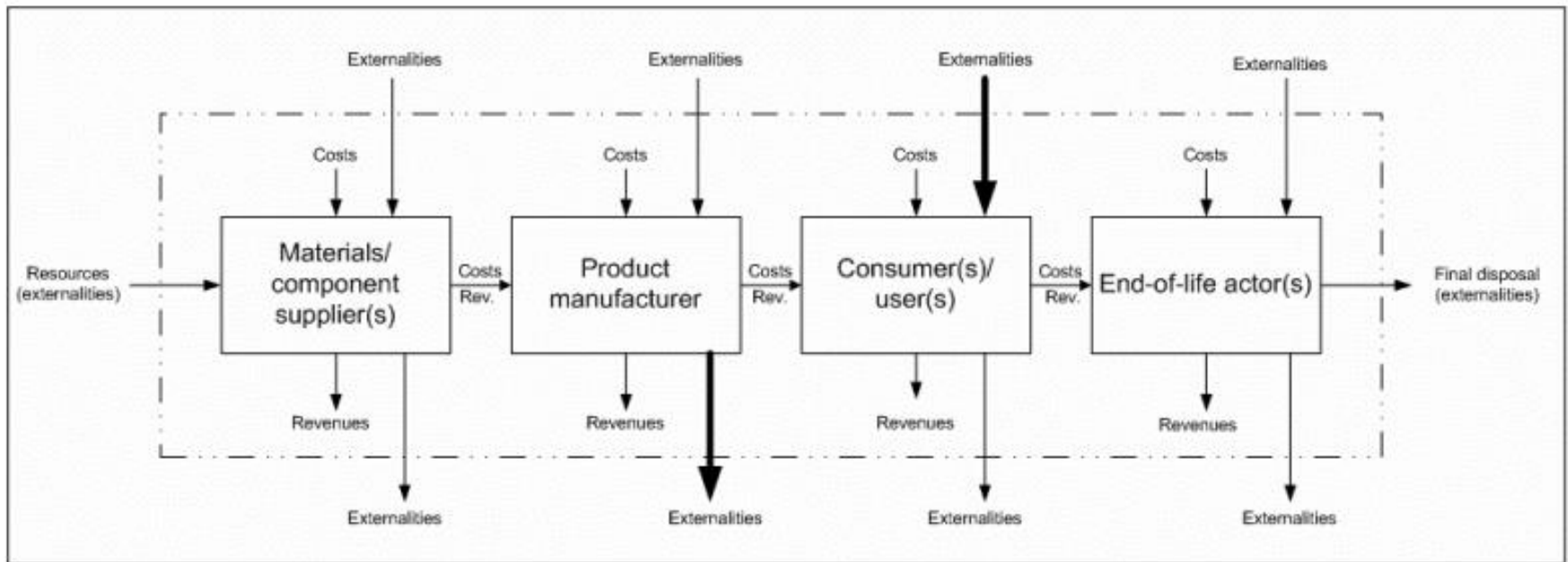
Source: Thomas Wolf - Eigenes Werk, CC BY-SA 2.5,
<https://commons.wikimedia.org/w/index.php?curid=2553428>


Several flavours of LCC


(E.g.):

- Conventional LCC: Outside of sustainability considerations, for procurement of investment goods
- LCC with externalities, single score: Monetising environmental impacts, an overall cost figure is calculated
- Environmental LCC: LCC to be applied in parallel to LCA
 - > similar life cycle;
 - > modelling consistent with LCA
 - > focus are real money flows – no double counting w. LCA

Environmental LCC, “conceptual framework”



 Economic system = boundaries of LCC

 Social and natural system: boundaries of social and environmental assessment

Source: Rebitzer G., Hunkeler D., Life Cycle Costing in LCM: Ambitions, opportunities, and limitations, Discussing a framework, In: Int J LCA 8 (5) 253-256, 2003

2 LCC implementation in openLCA

LCC in openLCA

(following the idea of Environmental LCC:)

- Recent project by US EPA
- Released with openLCA 1.5 (currently: beta1 released; final version 1.5 to be released this week)
- Also implemented: Value added (= negative costs)
- More information in handbook
 - **new!** [A results comparison of PSILCA SimaPro and openLCA](#)
 - **New!** [Regionalized LCIA in openLCA \(March 2016\)](#)
 - **New!** [Life Cycle Costing in openLCA \(March 2016\)](#)
 - **New!** [The PSILCA database \(March 2016\)](#)
 - **Updated!** [The database component v 2.2 in openLCA](#)

**(openLCA: free, open source, powerful
LCA and Sustainability Assessment
software, developed by GreenDelta
since 2006: www.openlca.org)**

LCC in openLCA: Entering costs for processes

- For processes, inputs and outputs: A new column was added for costs
- In this column, costs can be entered (optional):
 - For input flows, products
 - For input flows, elementary flows
 - For output flows, products
 - For output flows, elementary flows

LCC in openLCA: A simple example process

P Production of chair - DE

Process: Production of chair

Inputs

+ X 1.23

Flow	Category	Amount	Unit	Costs	Uncertainty	Provider	Pedigree unc...	Descr...
Electricity		2.00000	MJ	10.0 USD	none			
Wood		5.00000	kg	5.0 USD	none			

Outputs

+ X 1.23

Flow	Category	Amount	Unit	Costs/Reven...	Uncertainty	Avoided pro...	Pedigree unc...	Descr...
Chair		1.00000	Item(s)	25.0 USD	none			

General information Inputs/Outputs Administrative information Modeling and validation Parameters Allocation Social aspects

LCC in openLCA: Entering costs for processes

- Logic for cost values:
 - For input flows, products - costs
 - For input flows, elementary flows - costs
 - For output flows, products - revenues
 - For output flows, elementary flows - costs

LCC in openLCA: economic allocation, openLCA < 1.5

- (economic allocation: splitting a process which has > 1 product according to the prices of the products)
- In previous versions of openLCA: Flows have flow properties; an economic flow property can be added -> this is used for economic allocation...
- ...which works but cannot reflect different prices for the same product in different processes

LCC in openLCA: economic allocation, openLCA < 1.5

P Production of chair - DE P Use of chair - US F *Electricity

Flow: Electricity

▼ Flow properties

Name	Conversion factor	Reference unit	Formula	Is reference
Energy	1.0	MJ	1.0 MJ = 1.0 MJ	<input checked="" type="checkbox"/>
Market value, bulk prices	0.085	EUR 2000	1.0 MJ = 0.085 EUR 2000	<input type="checkbox"/>

General information Flow properties

LCC in openLCA: economic allocation, openLCA ≥ 1.5

In addition to the previous possibility...

- ...which works but cannot reflect different prices for the same product in different processes:
- Costs/revenues specified for products are considered for the economic allocation,
- ONLY IF these costs are not provided, costs/prices for flows are considered.

→ There is a hierarchy.

LCC calculation in openLCA ≥ 1.5

Description

Calculation properties

Please select the properties for the calculation

Allocation method: Physical

Impact assessment method:

Normalization and weighting set:

Calculation type:

- Quick results
- Analysis
- Regionalized LCIA
- Monte Carlo Simulation

Number of iterations: 100

Include cost calculation

Finish Cancel

LCC calculation in openLCA ≥ 1.5

Description

Calculation properties

Please select the properties for the calculation

Allocation method: Physical

Impact assessment method: [dropdown]

Normalization and weighting set: [dropdown]

Calculation type: Quick results Monte Carlo Simulation

Number of iterations: 100

Include cost calculation

Finish Cancel

Cost / value added calculation is an optional part of results, if not checked -> not calculated.

When checked, a separate dimension is calculated and displayed, in parallel to results of LCI and LCIA.

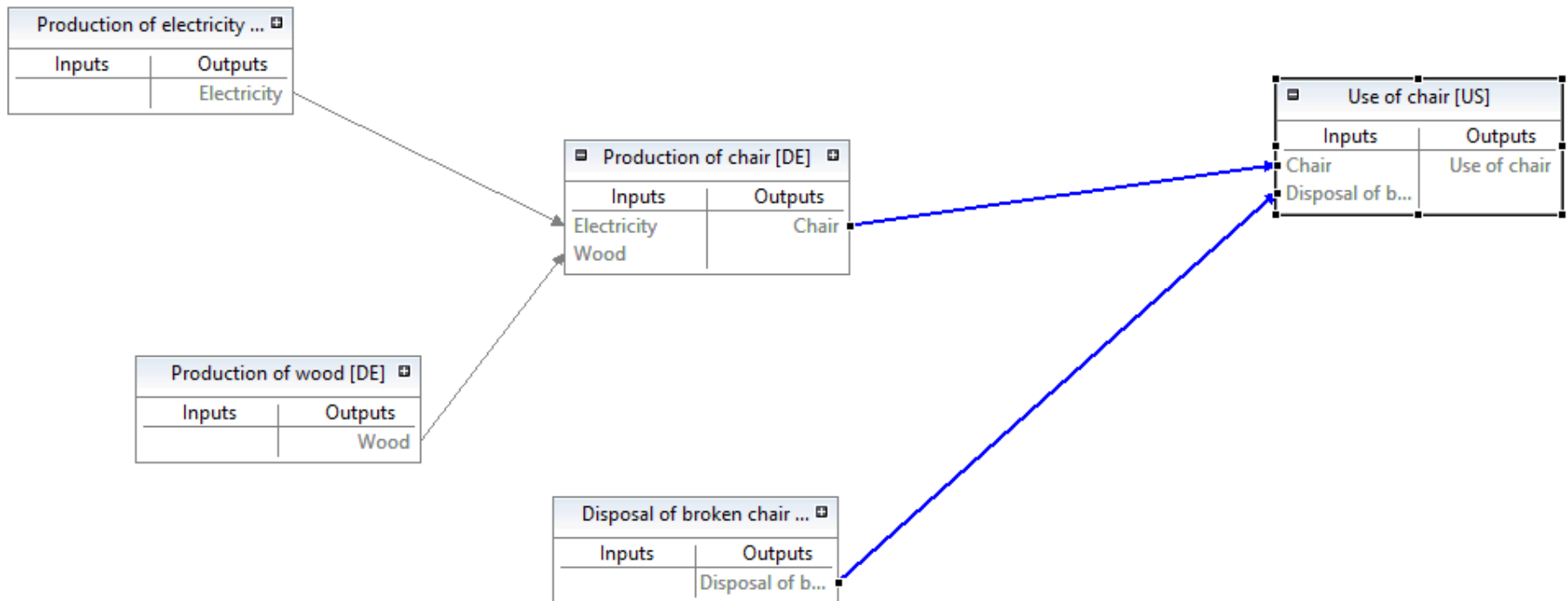
3 An example: Life cycle of a chair

A first simple example for LCC: Production, use and disposal of a chair

- Taken from Moreau/ Weidema: The computational structure of environmental life cycle costing, Int J Life Cycle Assess (2015) 20:1359–136



A first simple example for LCC: Production, use and disposal of a chair



A first simple example for LCC: Production, use and disposal of a chair

P Production of chair - DE P Use of chair - US F Electricity U Use of chair

Process: Production of chair

▼ Inputs + × 1.23

Flow	Category	Amount	Unit	Costs	Uncertainty	Provider	Pedigree unc...	Descr...
F Electricity		2.00000	U MJ	10.0 USD	none			
F Wood		5.00000	U kg	5.0 USD	none			

▼ Outputs + × 1.23

Flow	Category	Amount	Unit	Costs/Reven...	Uncertainty	Avoided pro...	Pedigree unc...	Descr...
F Chair		1.00000	U Item(s)	25.0 USD	none			

A first simple example for LCC: Production, use and disposal of a chair

- Costs are entered for the amount specified in the process

section bar rolling, steel market...	241:Manufacture of basic...	4.39840E4	kg	46268.836848	Edit	lognormal: g...
building, hall, steel construction ...	410:Construction of buil...	6883.00000	m2	45392.449827439 EUR		lognormal: g...
electronics, for control units m...	265:Manufacture of elec...	25.00000	kg	610.2607632000000 EUR		lognormal: g...
refractory spent pot liner from Al...	382:Waste treatm...					al: g...
Occupation, industrial area, built...	resource/land					al: g...
sheet rolling, chromium steel ...	241:Manufacture					al: g...
Transformation, from unknown	resource/land					al: g...
concrete, sole plate and foundati...	239:Manufacture					al: g...
concrete, high exacting require...	239:Manufacture					al: g...
Transformation, to industrial are...	resource/land					al: g...
graphite market for graphite - ...	089:Mining and					al: g...
glass fibre reinforced plastic, pol...	131:Spinning, we					al: g...
steel chromium steel 18/8, hot r...	241:Manufacture					al: g...

Price

Currency: EUR2016

Costs: 46268.836848 EUR

Costs per unit: 1.051947 EUR / kg

OK

A first simple example for LCC: Production, use and disposal of a chair

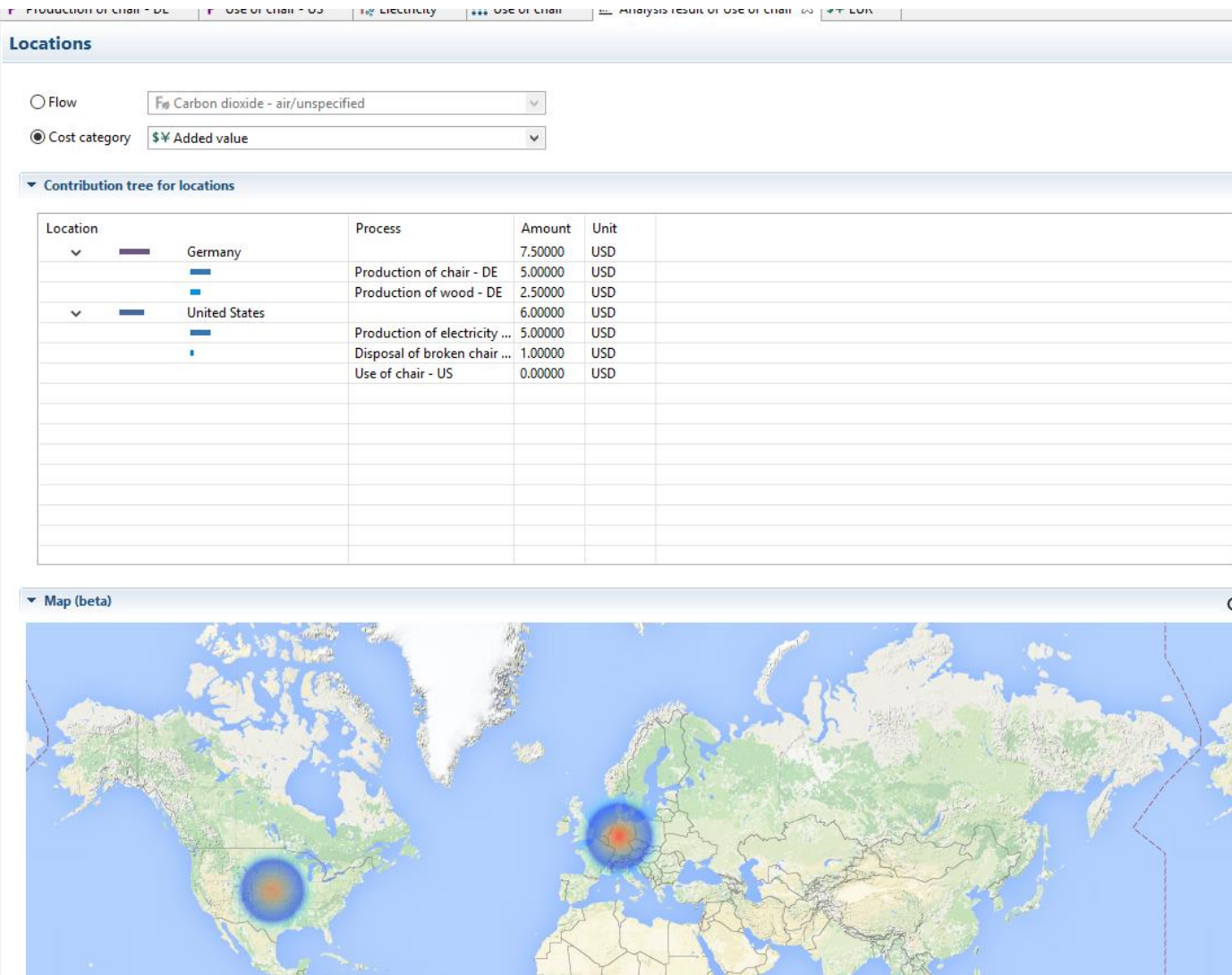
Costs/Added values

Costs \$¥ Added value

Cut-off 0 %

Contribution	Process	Amount	Unit
37.04%	Production of chair - DE	5.00000	USD
37.04%	Production of electricity - US	5.00000	USD
18.52%	Production of wood - DE	2.50000	USD
07.41%	Disposal of broken chair - US	1.00000	USD
00.00%	Use of chair - US	0.00000	USD

A first simple example for LCC: Production, use and disposal of a chair



A first simple example for LCC: Production, use and disposal of a chair

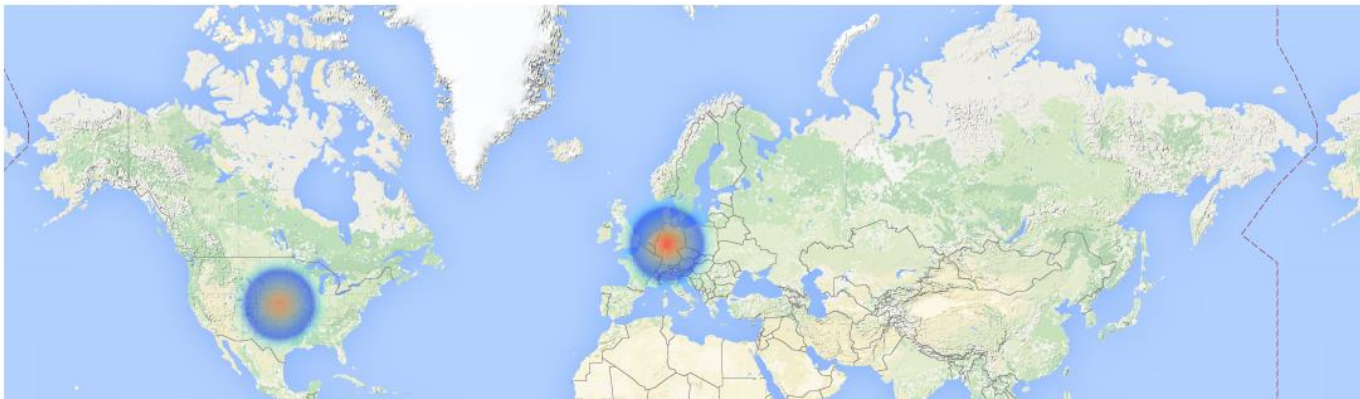
Production of Chair - DE Use of Chair - US Electricity Use of Chair Analysis result of Use of Chair LCC

Locations

Flow Carbon dioxide - air/unspecified

Cost category \$¥ Added value

Let's see it live...



4 An example with ecoinvent

The ecoinvent database extended with costs

- Ecoinvent datasets already contain costs for some products (which are used for allocation in the preparation of the system models), but
 - “hidden” in ecoSpold2 exchange properties – not shown in any software
 - Incomplete (for ca. 7000 products no price information)
 - Varying quality
- Costs added and partially corrected by GreenDelta

The ecoinvent database extended with costs

Process: housing system construction, cattle, loose | housing system, cattle, loose, per animal unit | cut-off, U

Inputs

+ X 1.23

Flow	Category	Amount	Unit	Costs	Uncertainty	Provider	Pedigree unc...	Descr...
aluminium, cast alloy market f...	242:Manufacture of basi...	7.71200	kg	12.130975999...	lognormal: g...	P market fo...		
waste polyurethane foam mar...	382:Waste treatment an...	-5.43000	kg		lognormal: g...	P market fo...		
fibre cement facing tile market...	239:Manufacture of non...	877.00000	kg	634281.33003...	lognormal: g...	P market fo...		
polyethylene, high density, gran...	201:Manufacture of basi...	10.60000	kg	9.4704585303...	lognormal: g...	P market fo...		
Occupation, construction site	resource/land	122.00000	m2*a		lognormal: g...			
fibre cement corrugated slab ...	239:Manufacture of non...	152.00000	kg	8.539403168 ...	lognormal: g...	P market fo...		
sanitary ceramics market for sa...	239:Manufacture of non...	226.00000	kg	909.36117810...	lognormal: g...	P market fo...		
electricity, low voltage market ...	351:Electric power gener...	120.00000	kWh	15.5364 EUR	lognormal: g...	P market fo...		
glass fibre market for glass fibr...	231:Manufacture of glas...	8.80000	kg	8.5363004672...	lognormal: g...	P market fo...		
excavation, hydraulic digger m...	431:Demolition and site ...	53.70000	m3	386.28397345...	lognormal: g...	P market fo...		
waste concrete, not reinforced ...	382:Waste treatment an...	-4590.00000	kg		lognormal: g...	P market fo...		
sawnwood, softwood, dried (u=...	161:Sawmilling and plan...	6.25000	m3	1141.9375 EUR	lognormal: g...	P market fo...		
zinc coat, coils market for zinc ...	259:Manufacture of othe...	12.00000	m2	0.468857868 ...	lognormal: g...	P market fo...		
particle board, for indoor use ...	162:Manufacture of pro...	1.10000	m3	288.12221372...	lognormal: g...	P market fo...		
glued laminated timber, for ind...	162:Manufacture of pro...	0.86200	m3	310.81996 EUR	lognormal: g...	P market fo...		
zinc coat, pieces market for zin...	259:Manufacture of othe...	25.90000	m2	1.0060163729...	lognormal: g...	P market fo...		
polystyrene foam slab market f...	222:Manufacture of plas...	6.12000	kg	0.329256 EUR	lognormal: g...	P market fo...		
steel, low-alloyed, hot rolled m...	241:Manufacture of basi...	56.50000	kg	28.16638 EUR	lognormal: g...	P market fo...		
glass fibre reinforced plastic, po...	131:Spinning, weaving a...	48.80000	kg	128.3403888 ...	lognormal: g...	P market fo...		
waste reinforced concrete mar...	382:Waste treatment an...	-3.23000E4	kg		lognormal: g...	P market fo...		
polypropylene, granulate mark...	201:Manufacture of basi...	1.75000	kg	1.6085811717...	lognormal: q...	P market fo...		

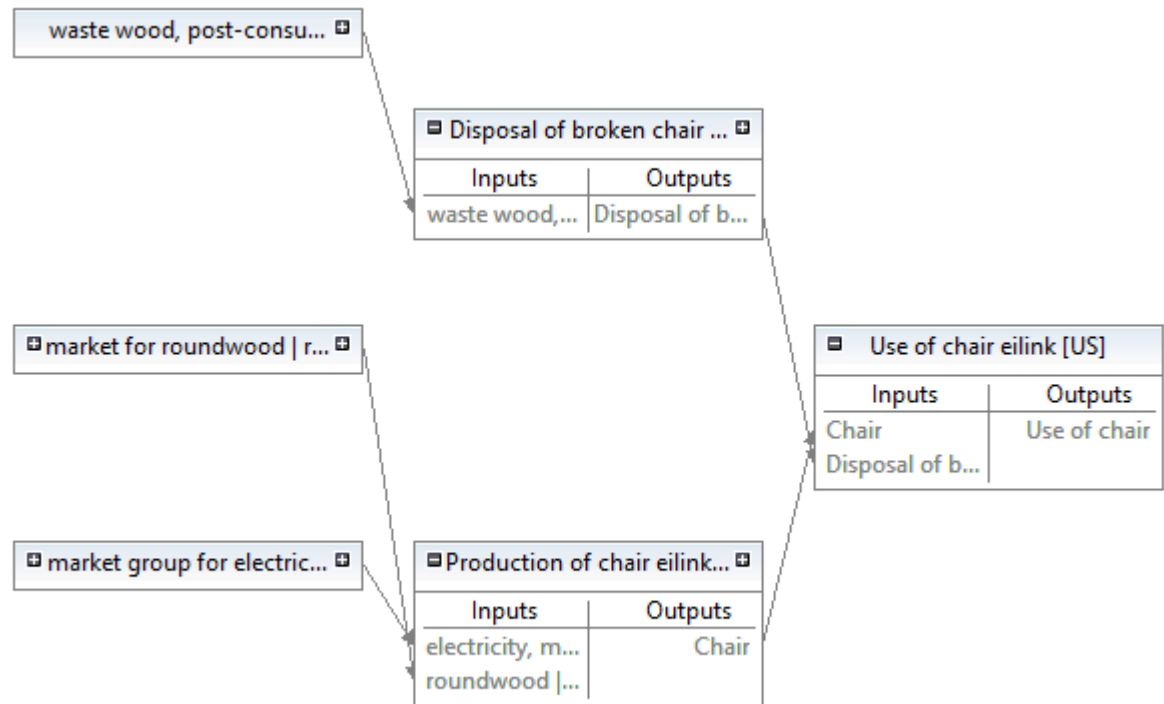
Outputs

+ X 1.23

Flow	Category	Amount	Unit	Costs/Reven...	Uncertainty	Avoided pro...	Pedigree unc...	Descr...
housing system, cattle, loose, p...	410:Construction of buil...	1.00000	Item(s)	1233.534777 ...	none			;

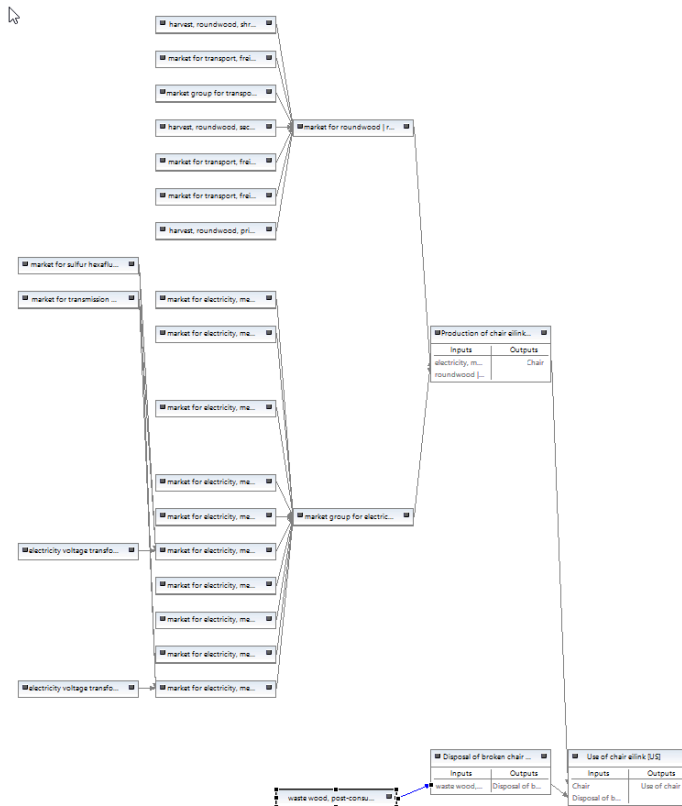
Revisiting the chair case study

- Now with a more complete supply chain (and replacement of the previous wood and electricity production)



Revisiting the chair case study

- Now with a more complete supply chain (and replacement of the previous wood and electricity production)



Revisiting the chair case study

Contribution tree

Flow

 Cost category

Contribution	Process	Amount	Unit
100.00%	Use of chair eilink - US	5.79789	EUR
94.56%	Production of chair eilink - DE	5.48228	EUR
07.27%	market for roundwood roundwood cut-off, U - GLO	0.42137	EUR
06.16%	harvest, roundwood, secondary forest roundwood cut-off, U - GLO	0.35708	EUR
01.08%	harvest, roundwood, primary forest roundwood cut-off, U - GLO	0.06236	EUR
00.86%	market for transport, freight, sea, transoceanic ship transport, freight, sea, transoceanic ship cut-off, U - ...	0.05007	EUR
00.11%	market for transport, freight, lorry, unspecified transport, freight, lorry, unspecified cut-off, U - GLO	0.00648	EUR
00.05%	market for transport, freight, light commercial vehicle transport, freight, light commercial vehicle cut-o...	0.00298	EUR
00.03%	market group for transport, freight train transport, freight train cut-off, U - GLO	0.00157	EUR
00.01%	harvest, roundwood, shrubland roundwood cut-off, U - GLO	0.00066	EUR
01.05%	market group for electricity, medium voltage electricity, medium voltage cut-off, U - US	0.06091	EUR
00.38%	market for electricity, medium voltage electricity, medium voltage cut-off, U - RFC	0.02216	EUR
00.38%	market for electricity, medium voltage electricity, medium voltage cut-off, U - SERC	0.02202	EUR
00.22%	market for electricity, medium voltage electricity, medium voltage cut-off, U - WECC, US only	0.01252	EUR
00.13%	market for electricity, medium voltage electricity, medium voltage cut-off, U - TRE	0.00770	EUR
00.12%	market for electricity, medium voltage electricity, medium voltage cut-off, U - MRO, US only	0.00688	EUR
00.06%	market for electricity, medium voltage electricity, medium voltage cut-off, U - FRCC	0.00323	EUR
00.05%	market for electricity, medium voltage electricity, medium voltage cut-off, U - SPP	0.00285	EUR
00.05%	market for electricity, medium voltage electricity, medium voltage cut-off, U - NPCC, US only	0.00275	EUR
00.00%	market for electricity, medium voltage electricity, medium voltage cut-off, U - HICC	0.00013	EUR
00.00%	market for electricity, medium voltage electricity, medium voltage cut-off, U - ASCC	7.92794E-5	EUR
05.44%	Disposal of broken chair eilink - US	0.31561	EUR

Revisiting the chair case study

Contribution tree

Flow

Cyanoacetic acid - air/high population density

Let's again see it live...

> 00.12%	market for electricity, medium voltage electricity, medium voltage cut-off, U - FRCC, US only	0.00000	EUR
> 00.06%	market for electricity, medium voltage electricity, medium voltage cut-off, U - FRCC	0.00323	EUR
> 00.05%	market for electricity, medium voltage electricity, medium voltage cut-off, U - SPP	0.00285	EUR
> 00.05%	market for electricity, medium voltage electricity, medium voltage cut-off, U - NPCC, US only	0.00275	EUR
> 00.00%	market for electricity, medium voltage electricity, medium voltage cut-off, U - HICC	0.00013	EUR
> 00.00%	market for electricity, medium voltage electricity, medium voltage cut-off, U - ASCC	7.92794E-5	EUR
> 05.44%	Disposal of broken chair eilink - US	0.31561	EUR

5 Questions

6 Summary & outlook

Summary and Outlook

- An improved way to perform LCC analyses is available in openLCA since version 1.5
- It allows calculation of value added and Life Cycle Costs, following the idea of environmental Life Cycle Costing
- An extension of the ecoinvent database will be published and maintained by GreenDelta, which provides cost and revenue figures for all data sets

GreenDELTA

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Thank you for your attention

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