openLCA in our times

Dr. Andreas Ciroth
CEO, GreenDelta GmbH
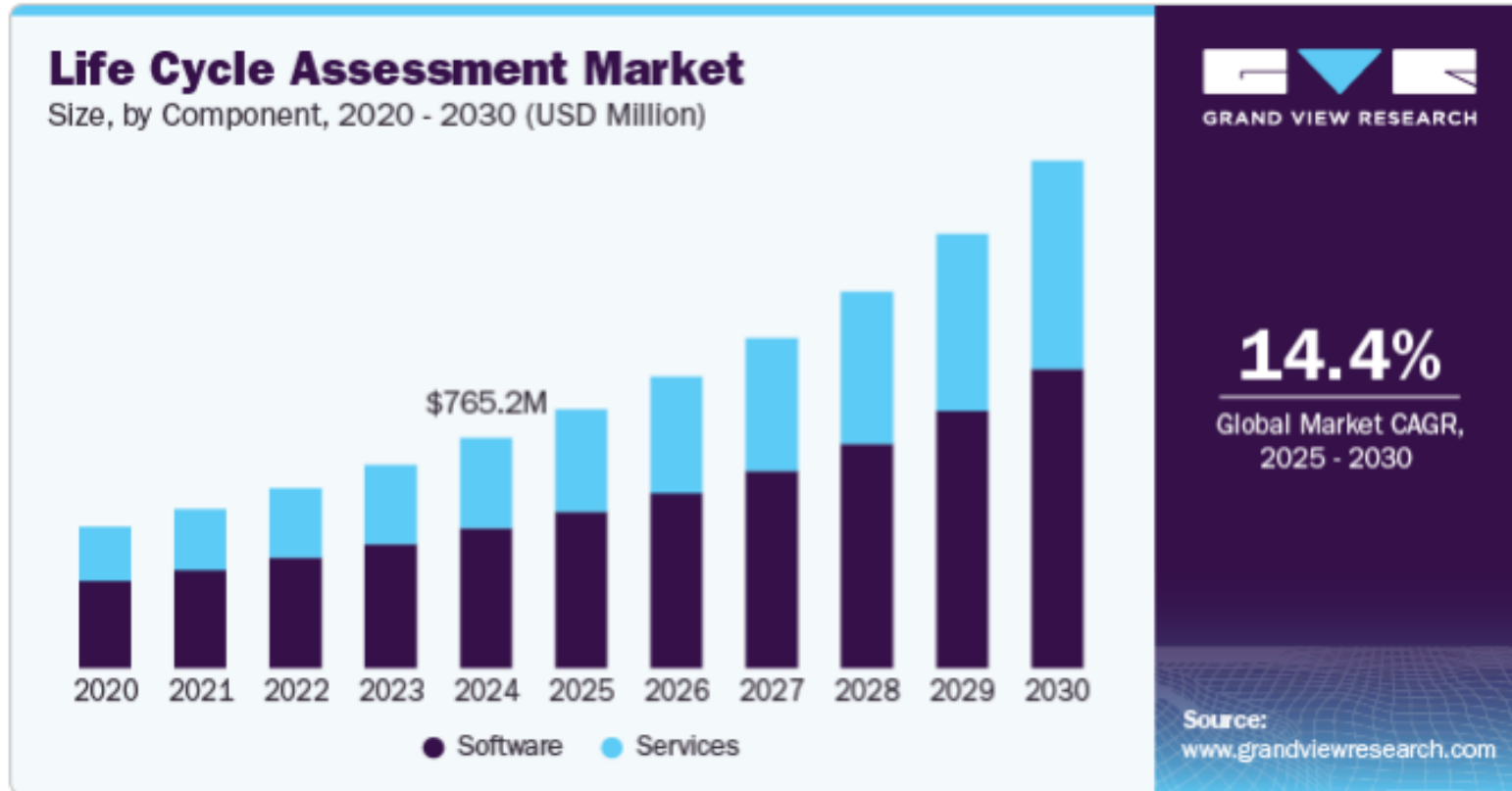
openLCA in our times

- **Sustainability and LCA have seen an enormous boost in the last ~ 30 years (maybe since RIO)**
- **Today:**
  1) **LCA is daily business practice (and even increasing in use)**
  2) **The "world's attention" is shifting (towards: defence, economy in general which is at stake, …)**
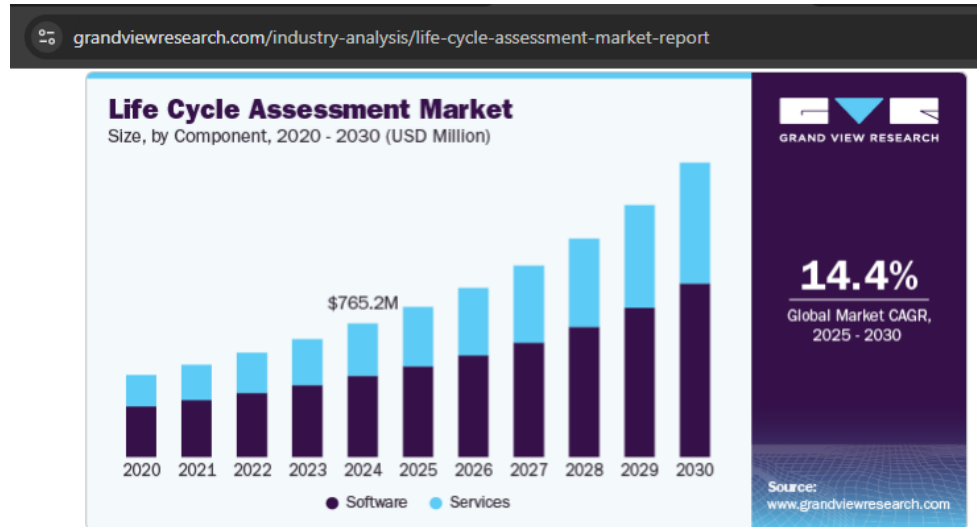 3) **LCA has still room for improvement**

LCA, a changing situation

LCA is daily business practice (and even increasing in use)

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LCA is daily business practice (and even increasing in use)

grandviewresearch.com/industry-analysis/life-cycle-assessment-market-report

Life Cycle Assessment Market
Size, by Component, 2020 - 2030 (USD Million)

GRAND VIEW RESEARCH

$765.2M

2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030

● Software ● Services

14.4%
Global Market CAGR,
2025 - 2030

Source:
www.grandviewresearch.com

PDF
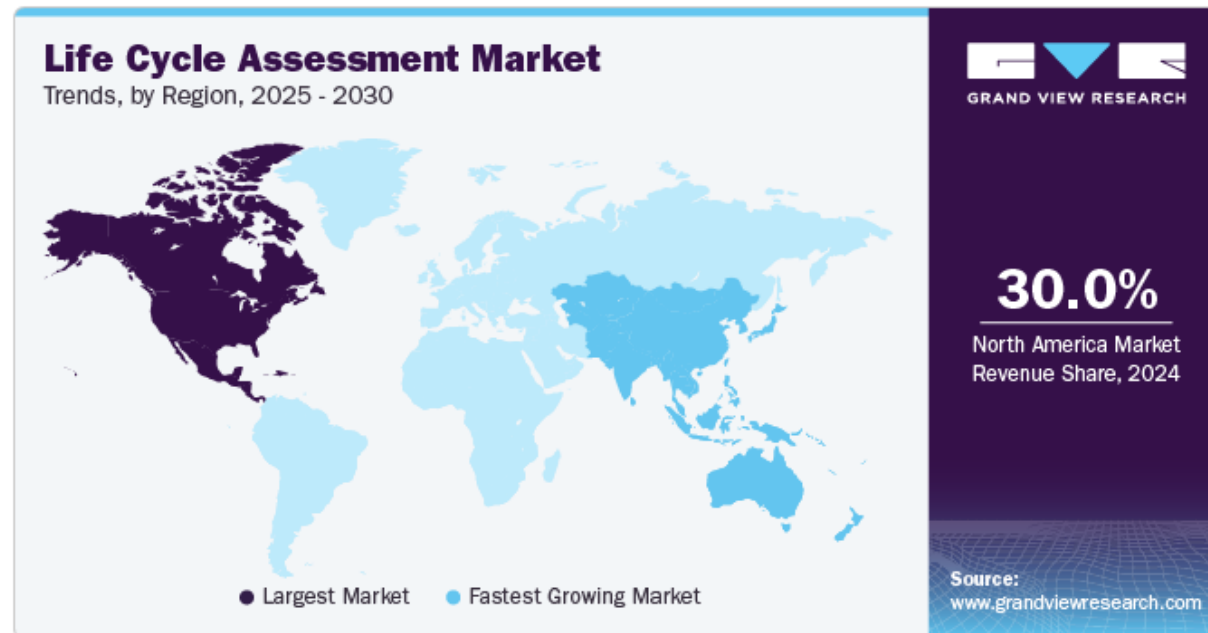
**Market
Analysis
Report**

**Life Cycle Assessment Market Size, Share & Trends Analysis Report By Component
(Software, Services), By Type (Cradle to Cradle, Cradle to Grave, Gate to Gate), By
Deployment, By Enterprise Size, By End-use, By Region, And Segment Forecasts, 2025 -
2030**

Report ID: GVR-4-68040-544-8 | Number of Report Pages: 150 | Format: PDF

Historical Range: 2018 - 2024 | Forecast Period: 2025 - 2030 | Industry: Technology

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The "world's attention" is shifting somewhat away from sustainability, maybe

Life Cycle Assessment Market
Trends, by Region, 2025 - 2030

GRAND VIEW RESEARCH

30.0%
North America Market
Revenue Share, 2024

● Largest Market ● Fastest Growing Market

Source:
www.grandviewresearch.com

Life Cycle Assessment Market Size, Share & Trends Analysis Report By Component (Software, Services), By Type (Cradle to Cradle, Cradle to Grave, Gate to Gate), By Deployment, By Enterprise Size, By End-use, By Region, And Segment Forecasts, 2025 - 2030

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The "world's attention" is shifting somewhat away from sustainability, maybe

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So, what to do with it?

So, what to do with it?

a) **LCA is still an excellent, unique, and needed methodology and approach**

b) **people might have less patience with imperfections and effort linked to LCA**

→**See that LCA becomes more effective and more efficient**

→**This is (for us) linked to openLCA**

More effective and efficient LCA:
LCA has still room for improvement

- **Cost and effort**

- **Data**

- **Modeling: does LCA really provide a holistic and realistic image for decision support?**

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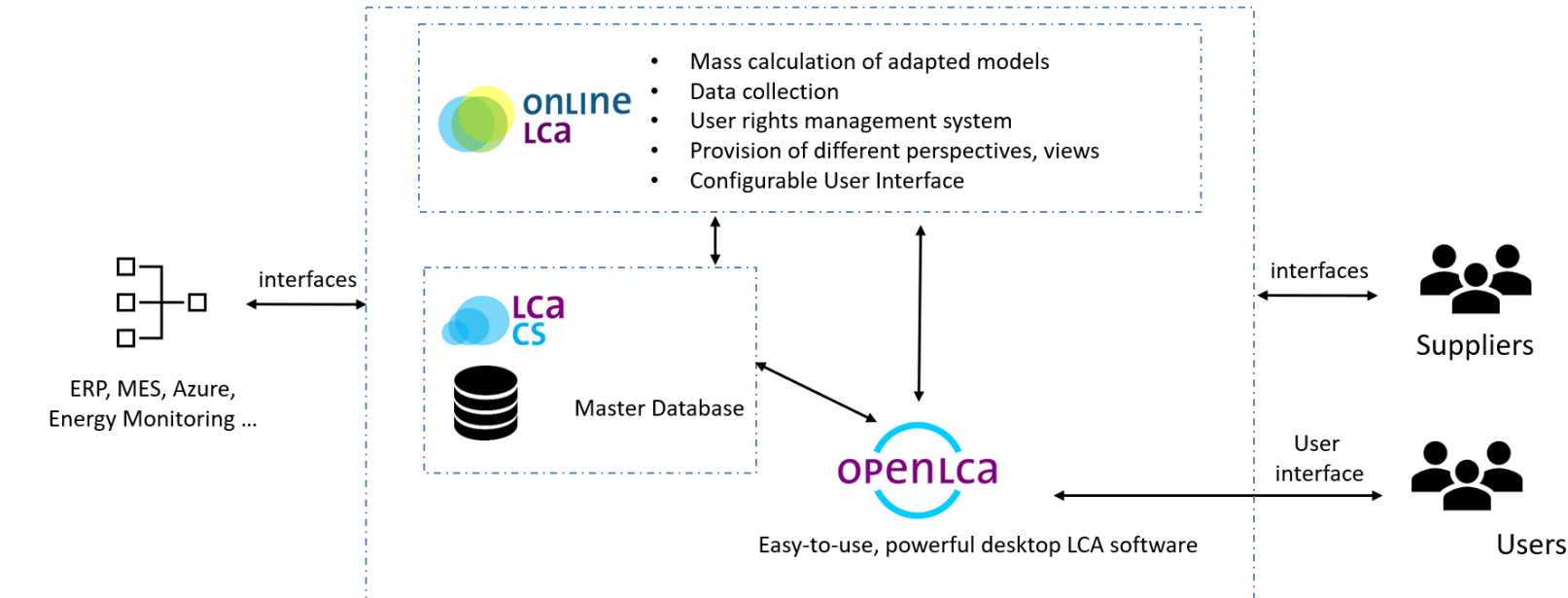# LCA has still room for improvement – cost and effort

- **Effort for an LCA study and "result"**
  - **Manual LCA modelling will of course always be needed,**
  - **but for the entire portfolio of a company e.g. this is not feasible.**
- **Software costs, database costs**

-> Tools to mass-create LCAs, tools that contain predefined models to change parameters only, tools for different types of users, ..

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LCA has still room for improvement – cost and effort

- **Effort for an LCA study and "result"**
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LCA has still room for improvement – cost and effort

- **Automated tools: from single tool to ecosystem of LCA tools for different users and application types**
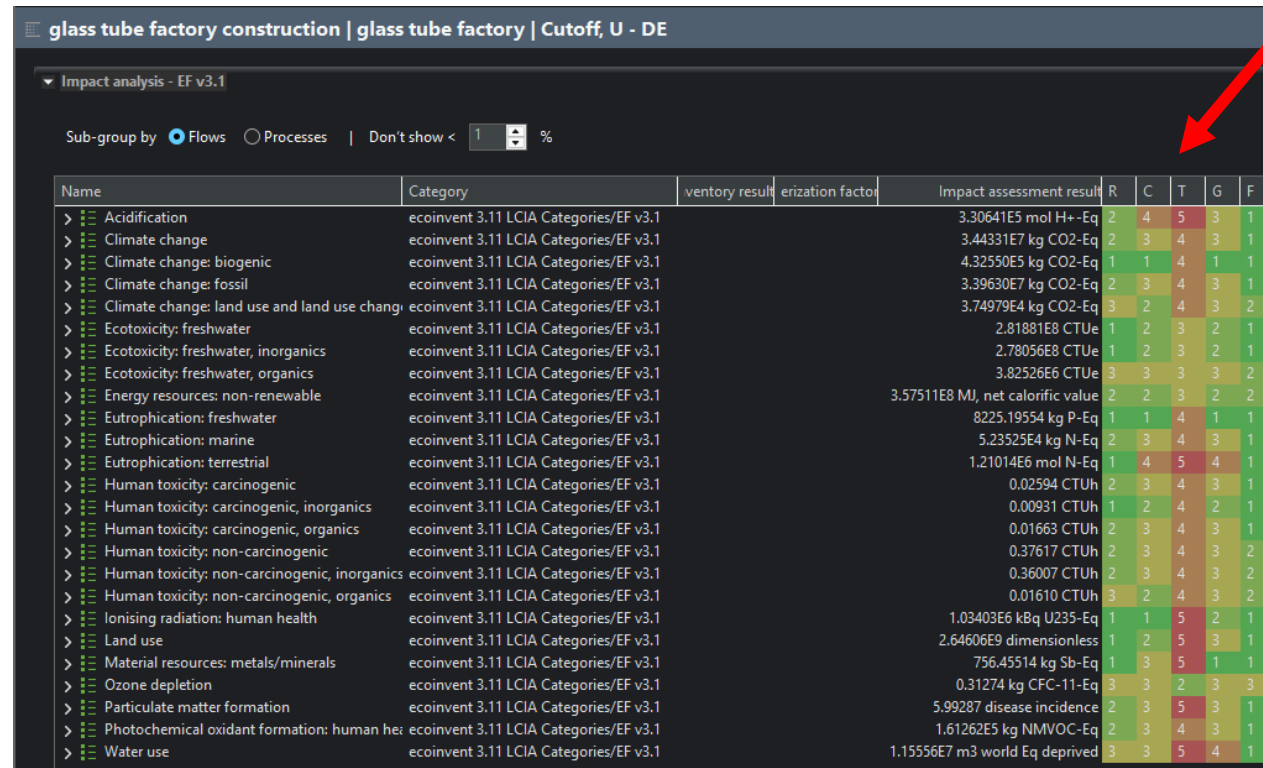- **E.g. for openLCA:**

- Mass calculation of adapted models
- Data collection
- User rights management system
- Provision of different perspectives, views
- Configurable User Interface

onLIne LCA

LCa CS

Master Database

openLCa

Easy-to-use, powerful desktop LCA software

interfaces

ERP, MES, Azure, Energy Monitoring …

interfaces

Suppliers

User interface

Users

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LCA has still room for improvement – data

- **Availability**

ecoinvent version and year	processes	products	locations
3.6 2019	18121	3146	294
3.7 2020	19271	3185	299
3.8 2021	19565	3292	300
3.9.1 2022	21238	3550	309
3.10 2023	23532	4031	330
3.11 2024	25413	4268	570

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LCA has still room for improvement – data

- **Age**

T: time as data quality indicator, ecoinvent 3.11 calculation.
5 = worst assessment, data is outdated

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LCA has still room for improvement – data

- **Licenses**

  Commercial databases have increasingly complicated and demanding licenses that make sharing models and data that contain parts of these difficult

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LCA has still room for improvement – data

- **Licenses**

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" While earlier versions of the database were entirely free e.g. for educational uses in France, this is now not possible any more, a problem seem the integrated ecoinvent datasets, as we learned from ADEME. We regret this (and see of course no relation to the announced "partnership"

Agribalyse v311 report, GreenDelta
2024, obtained from openLCA Nexus

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LCA has still room for improvement – data

- **Data exchange:**
  - **XML-based formats in Europe predominant, since ~ 20 years (ILCD, a bit EcoSpold1 and 2)**
  - **Meanwhile, outside of LCA, outdated**
    - **Slow, bulky, error-prone due to its verbosity**

  " XML had its golden age upon its creation. It contributed tremendously to data interchange in a universal language, transforming the world of computation. To these days […] it is often considered "antique" […].

  https://www.imaginarycloud.com/blog/json-vs-xml

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Inputs/Outputs - Bottling, from red wine, for red wine in a cooperative cellar, French production mix, at plant, 1 L of red wine (POUi) - FR

▾ Inputs

Flow	Category	Amount	Unit	Costs/Revenues	Uncertainty	Avoided waste	Provider	Data quality entr
Bag-in-box, at plant {RER} U - ...	material/Others	0.00080	kg		none			(1; 2; 1; 1; 1)
Bottle, PET, at plant {RER} U - ...	material/Others	0.00300	kg		none			(1; 2; 1; 1; 1)
Cardboard box, at plant - RER	material/Others	0.03000	kg		none			(1; 2; 1; 1; 1)
Electricity, medium voltage {F...	energy/Others/Copied from Eco...	0.00097	kWh		none			(2; 3; 2; 3; 2)
Glass bottles, at plant - RER	material/Others	0.49700	kg		none			(1; 2; 1; 1; 1)
Label, coated paper, at plant -...	material/Others	0.00200	kg		none			(1; 2; 1; 1; 1)
Natural cork stopper, at plant ...	material/Others	0.00400	kg		none			(1; 2; 1; 1; 1)
Over cap, PVC, for wine bottle...	material/Others	0.00100	kg		none			(1; 2; 1; 1; 1)
Plastic cork stopper, at plant {...	material/Others	0.00500	kg		none			(1; 2; 1; 1; 1)
Screw cap, aluminium, for wi...	material/Others	0.00500	kg		none			(1; 2; 1; 1; 1)
Water, well	../Resource/in water	1.98000E-5	m3		none			(4; 4; 2; 1; 2)

▾ Outputs

Flow	Category	Amount	Unit	Costs/Revenues	Uncertainty	Avoided product	Provider	Data quality entr
Bottling, from red wine, for ...	**processing/Agricultural**	**1.00000**	**l**		**none**			**(4; 4; 2; 1; 2)**
Treatment, sewage, to wastew...	waste treatment/Wastewater Tre...	6.85000E-5	m3		none			(4; 4; 2; 1; 2)
COD, Chemical Oxygen Dema...	../Emission to water/river	0.00282	kg		none			(1; 2; 1; 1; 1)
Suspended solids, unspecified	../Emission to water/surface water	0.00000	kg		none			(1; 2; 1; 1; 1)

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```xml
163    </generalComment>
165            <exchange xmlns:olca="http://openlca.org/ilcd-extensions" dataSetInternalID="8" olca:unitId="20aadc24-a391-41cf-b340-3e4529f44bde" olca:propertyId="93a60a56-a3c8-11da-a746-0800200b9a66" olca:pedigreeUncertainty="(1;2;1;1;1)" old
170                <meanAmount>0.002</meanAmount>
171                <resultingAmount>0.002</resultingAmount>
172                <generalComment xml:lang="en">(1,2,1,1,1);
173    </generalComment>
174            </exchange>
175            <exchange xmlns:olca="http://openlca.org/ilcd-extensions" dataSetInternalID="9" olca:unitId="20aadc24-a391-41cf-b340-3e4529f44bde" olca:propertyId="93a60a56-a3c8-11da-a746-0800200b9a66" olca:pedigreeUncertainty="(1;2;1;1;1)" old
176                <referenceToFlowDataSet type="flow data set" refObjectId="228af7b1-07f3-3401-868d-8ab384068758" version="00.00.001" uri="../flows/228af7b1-07f3-3401-868d-8ab384068758.xml">
177                    <common:shortDescription xml:lang="en">Bag-in-box, at plant {RER} U</common:shortDescription>
178                </referenceToFlowDataSet>
179                <exchangeDirection>Input</exchangeDirection>
180                <meanAmount>8.0E-4</meanAmount>
181                <resultingAmount>8.0E-4</resultingAmount>
182                <generalComment xml:lang="en">(1,2,1,1,1);
183    </generalComment>
184            </exchange>
185            <exchange xmlns:olca="http://openlca.org/ilcd-extensions" dataSetInternalID="14" olca:unitId="20aadc24-a391-41cf-b340-3e4529f44bde" olca:propertyId="93a60a56-a3c8-11da-a746-0800200b9a66" olca:pedigreeUncertainty="(1;2;1;1;1)" ol
186                <referenceToFlowDataSet type="flow data set" refObjectId="75a4db8c-cc6c-4da5-a511-cf68acdad348" version="00.00.000" uri="../flows/75a4db8c-cc6c-4da5-a511-cf68acdad348.xml">
187                    <common:shortDescription xml:lang="en">COD, Chemical Oxygen Demand</common:shortDescription>
188                </referenceToFlowDataSet>
189                <exchangeDirection>Output</exchangeDirection>
190                <meanAmount>0.00282</meanAmount>
191                <resultingAmount>0.00282</resultingAmount>
192                <generalComment xml:lang="en">(1,2,1,1,1);
193    </generalComment>
194            </exchange>
195            <exchange xmlns:olca="http://openlca.org/ilcd-extensions" dataSetInternalID="15" olca:unitId="20aadc24-a391-41cf-b340-3e4529f44bde" olca:propertyId="93a60a56-a3c8-11da-a746-0800200b9a66" olca:pedigreeUncertainty="(1;2;1;1;1)" ol
196                <referenceToFlowDataSet type="flow data set" refObjectId="3844f446-ded5-4727-8421-17a00ef4eba7" version="00.00.001" uri="../flows/3844f446-ded5-4727-8421-17a00ef4eba7.xml">
197                    <common:shortDescription xml:lang="en">Suspended solids, unspecified</common:shortDescription>
198                </referenceToFlowDataSet>
199                <exchangeDirection>Output</exchangeDirection>
200                <meanAmount>0.0</meanAmount>
201                <resultingAmount>0.0</resultingAmount>
202                <generalComment xml:lang="en">(1,2,1,1,1);
203    </generalComment>
204            </exchange>
205            <exchange xmlns:olca="http://openlca.org/ilcd-extensions" dataSetInternalID="12" olca:unitId="1c3a9695-398d-4b1f-b07e-a8715b610f70" olca:propertyId="93a60a56-a3c8-22da-a746-0800200c9a66" olca:pedigreeUncertainty="(4;4;2;1;2)" ol
206                <referenceToFlowDataSet type="flow data set" refObjectId="0fd0f5ee-bce3-3cc7-8dfc-f00711dd2929" version="00.00.001" uri="../flows/0fd0f5ee-bce3-3cc7-8dfc-f00711dd2929.xml">
207                    <common:shortDescription xml:lang="en">Treatment, sewage, to wastewater treatment {CH} U</common:shortDescription>
208                </referenceToFlowDataSet>
209                <exchangeDirection>Output</exchangeDirection>
210                <meanAmount>6.85E-5</meanAmount>
211                <resultingAmount>6.85E-5</resultingAmount>
212                <generalComment xml:lang="en">(4,4,2,1,2);
213    </generalComment>
214            </exchange>
215            <exchange xmlns:olca="http://openlca.org/ilcd-extensions" dataSetInternalID="13" olca:unitId="1c3a9695-398d-4b1f-b07e-a8715b610f70" olca:propertyId="93a60a56-a3c8-22da-a746-0800200c9a66" olca:pedigreeUncertainty="(4;4;2;1;2)" ol
216                <referenceToFlowDataSet type="flow data set" refObjectId="67c40aae-d403-464d-9649-c12695e43ad8" version="00.00.000" uri="../flows/67c40aae-d403-464d-9649-c12695e43ad8.xml">
217                    <common:shortDescription xml:lang="en">Water, well</common:shortDescription>
218                </referenceToFlowDataSet>
219                <exchangeDirection>Input</exchangeDirection>
220                <meanAmount>1.98E-5</meanAmount>
221                <resultingAmount>1.98E-5</resultingAmount>
222                <generalComment xml:lang="en">(4,4,2,1,2);
```

```json
 43        "exchanges": [
105            {
107                "isAvoidedProduct": false,
108                "isInput": true,
109                "amount": 8.0E-4,
110                "dqEntry": "(1;2;1;1;1)",
111                "description": "(1,2,1,1,1);\n",
112                "internalId": 9,
113                "flow": {
114                    "@type": "Flow",
115                    "@id": "228af7b1-07f3-3401-868d-8ab384068758",
116                    "name": "Bag-in-box, at plant {RER} U",
117                    "category": "material/Others",
118                    "flowType": "PRODUCT_FLOW",
119                    "location": "RER",
120                    "refUnit": "kg"
121                },
122                "unit": {
123                    "@type": "Unit",
124                    "@id": "20aadc24-a391-41cf-b340-3e4529f44bde",
125                    "name": "kg"
126                },
127                "flowProperty": {
128                    "@type": "FlowProperty",
129                    "@id": "93a60a56-a3c8-11da-a746-0800200b9a66",
130                    "name": "Mass",
131                    "category": "Technical flow properties",
132                    "refUnit": "kg"
133                }
134            },
135            {
136                "@type": "Exchange",
137                "isAvoidedProduct": false,
138                "isInput": true,
139                "amount": 0.003,
140                "dqEntry": "(1;2;1;1;1)",
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142                "internalId": 10,
143                "flow": {
144                    "@type": "Flow",
145                    "@id": "e956feae-92b6-30b6-bbc2-ac874f58f6e9",
146                    "name": "Bottle, PET, at plant {RER} U",
147                    "category": "material/Others",
148                    "flowType": "PRODUCT_FLOW",
149                    "location": "RER",
150                    "refUnit": "kg"
151                },
152                "unit": {
153                    "@type": "Unit",
154                    "@id": "20aadc24-a391-41cf-b340-3e4529f44bde",
155                    "name": "kg"
156                },
```
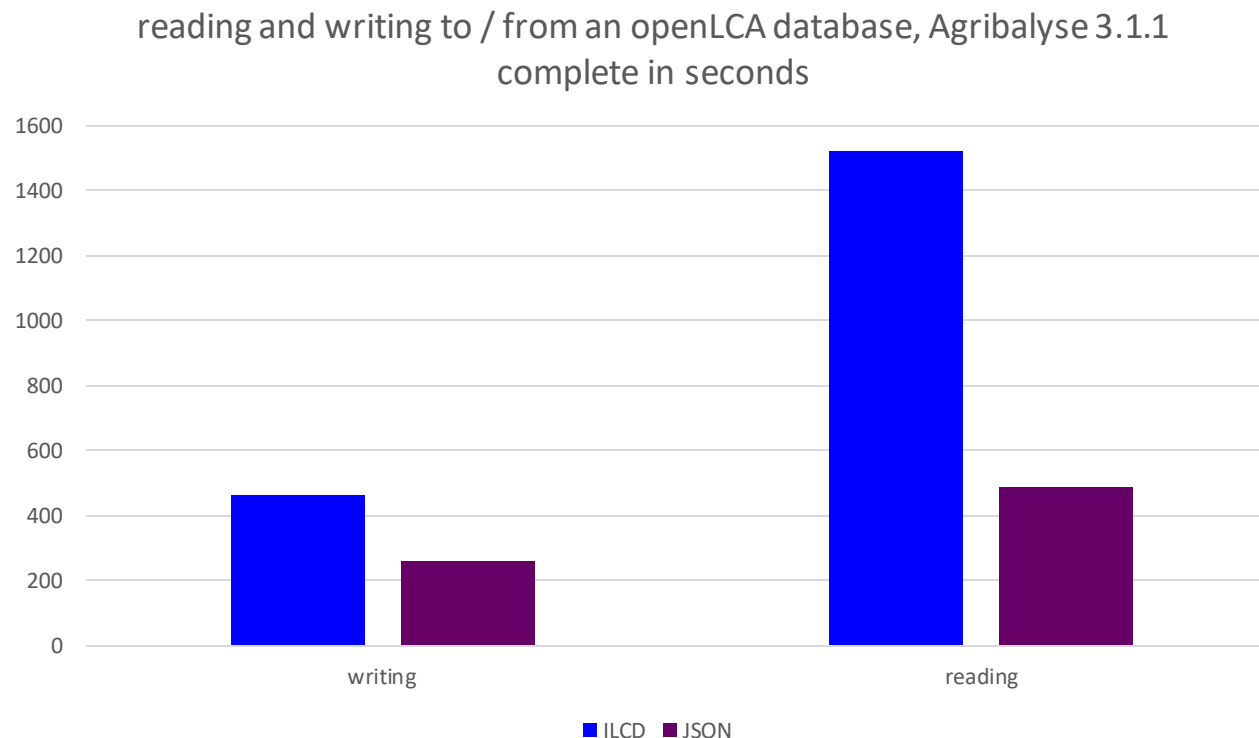
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JSON vs ILCD

- **Agribalyse 3.1.1, full export and full import, using openLCA 2.4.1**

reading and writing to / from an openLCA database, Agribalyse 3.1.1
complete in seconds

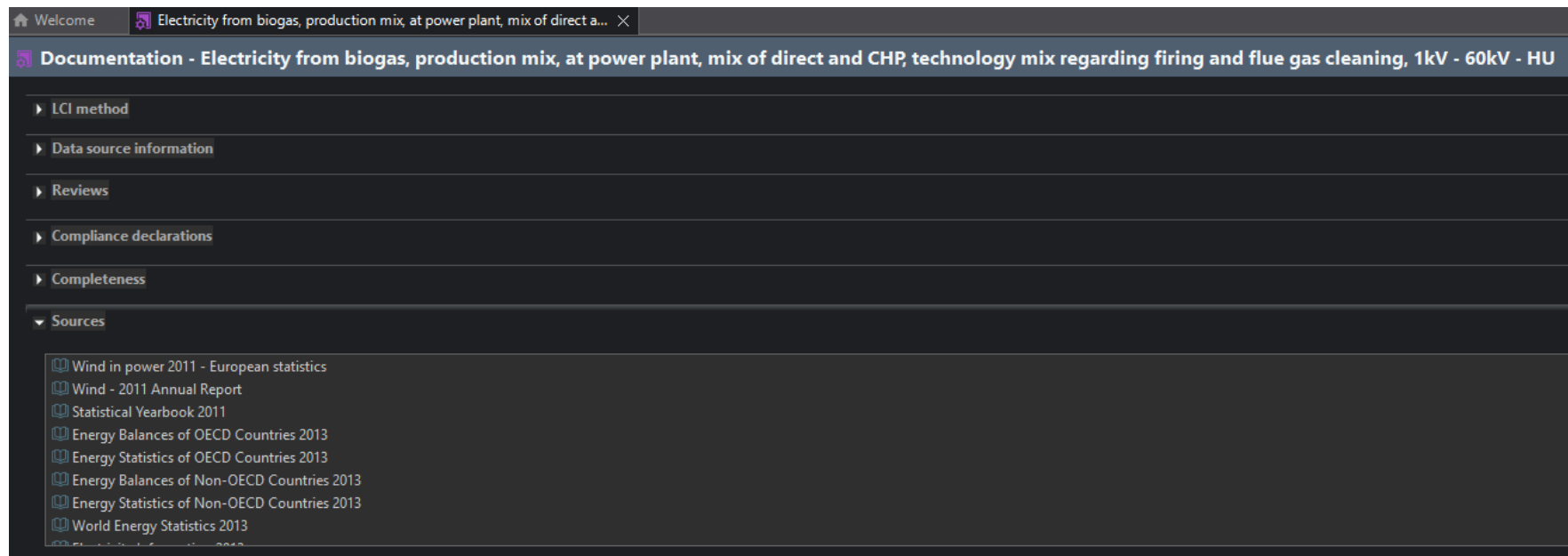ILCD JSON

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LCA has still room for improvement – data

- **Lack of traceability and clarity**
  - **system processes**
  - **lack of documentation**
 - **flooding with unfitting documentation**

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LCA has still room for improvement – data

- **flooding with unfitting documentation**
- **All the sources listed for
"Electricity from biogas, production mix, at power plant, mix of direct and CHP, technology mix regarding firing and flue gas cleaning, 1kV - 60kV", Hungary (EF31 database)**
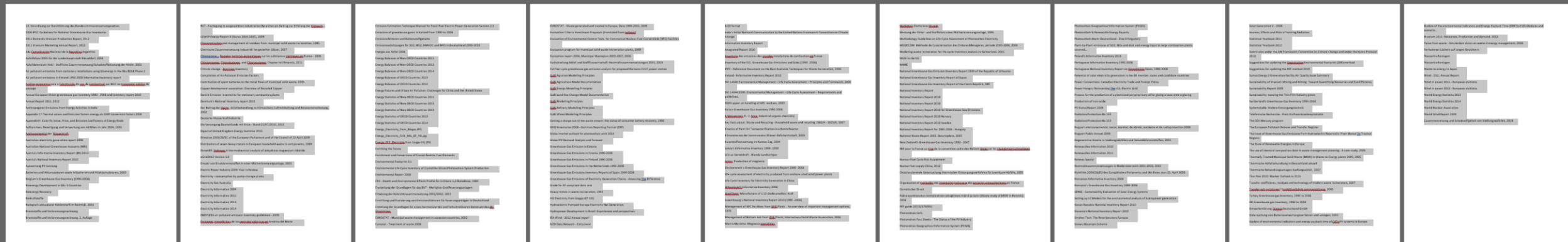
- **Some of the sources listed for "Electricity from biogas, production mix, at power plant, mix of direct and CHP, technology mix regarding firing and flue gas cleaning, 1kV - 60kV", Hungary (EF31 database)**

ISWA paper on handling of APC residues, 2003

Italian Greenhouse Gas Inventory 1990-2008

K.Weissermel, H.- J. Arpe: Industrial organic chemistry

Key facts about: Waste and Recycling - Household waste and recycling 1983/4 - 2005/6, 2007

Kinetics of Palm Oil Transesterification in a Batch Reactor

Klimarelevanz der kommunalen Wiener Abfallwirtschaft, 2005

Kunststoffverwertung im Kanton Zug, 2004

Latvia's Informative Inventory 1990- 2008

LCA av Vattenkraft - Blanda Landsvirkjun

Levos- Production of magnesia

Liechtenstein`s Greenhouse Gas Inventory Report 1990 -2008

Life cycle assessment of electricity produced from onshore sited wind power plants
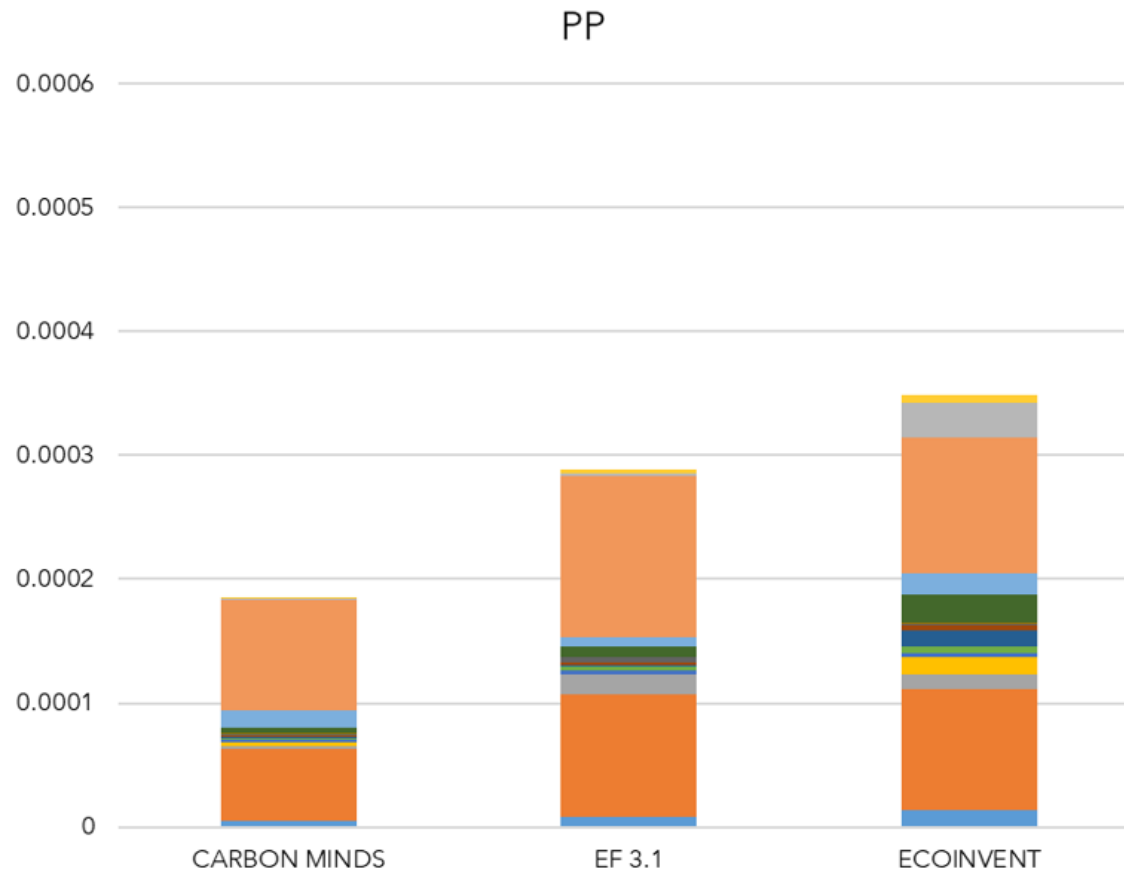
Life Cycle Inventory for Electricity Generation in China

Lithuanians's Informative Inventory 2008

LookChem: Manufacture of 1.12-Dodecanedioic Acid

Luxembourg´s National Inventory Report 2010 (1990 -2008)

LCA has still room for improvement – data

PP

1 kg PP production, same model, different background databases, LCIA method EF3.1, single score
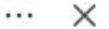
Legend:
- acidification
- gwp100
- ecotoxicity: freshwater
- eutrophication: freshwater
- eutrophication: marine
- eutrophication: terrestrial
- human toxicity: carcinogenic
- human toxicity: non-carcinogenic
- ionising radiation: human health
- land use
- ozone depletion
- particulate matter formation
- photochemical oxidant formation
- energy resources: fossil fuels
- material resources: metals/minerals
- water use

Cilleruelo, J., Hoffmann, J., Bringmann, M., Ciroth, A.: 50 Ecoprofiles and 200 datasets from the PRIMUS Demo cases, PRIMUS D6.3, 2025

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LCA has still room for improvement – data

- **Communication and perception vs. reality**
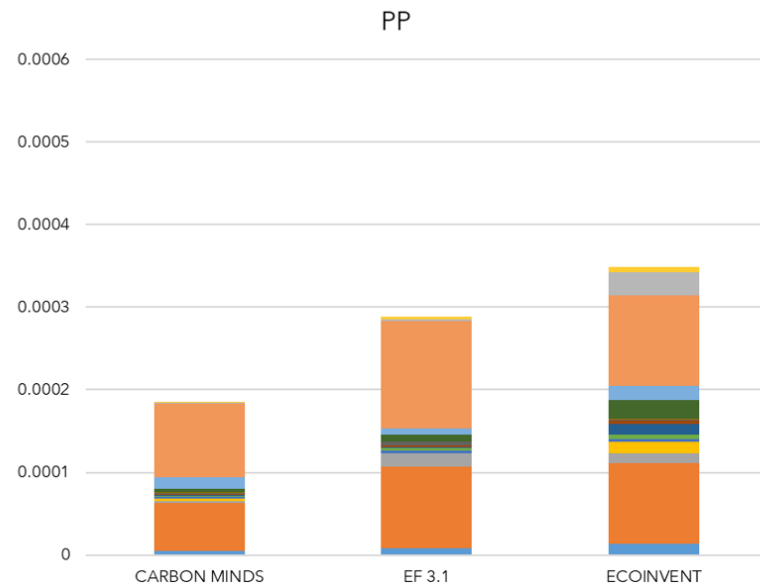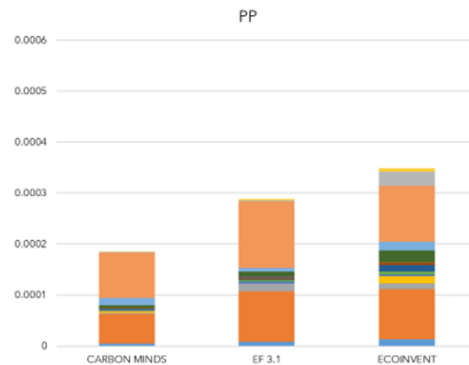
LCA has still room for improvement – data

While science provides solid methodologies and results for this transition, data plays a fundamental role in maintaining a robust and transparent scientific backbone to provide the correct support to policymakers as well as B2C communication.

PP

- **Communication and perception vs. reality**

LCA has still room for improvement – data

- **DGNB (deutsche Gesellschaft für Nachhaltiges Bauen): database fka GaBi must be used for life cycle models in the DGNB certification**

- **Geschäftsführender Vorstand: Johannes Kreissig, formerly PE International / GaBi**

LCA has still room for improvement - Modeling and method

- **Basic idea of LCA: provide a holistic picture of impacts linked to a product / service over the life cycle, so that burden shifting is avoided.**

- **Is this achieved?**

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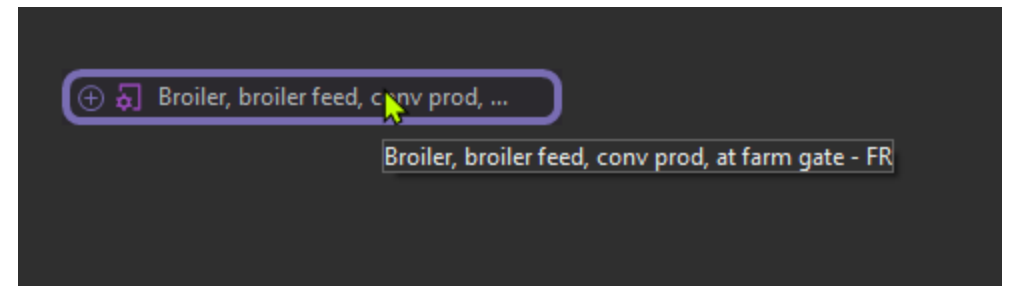# LCA has still room for improvement - Modeling and method

- Basic idea of LCA: provide a holistic picture of impacts linked to a product / service over the life cycle, so that burden shifting is avoided.

- Is this achieved?

- **Linear model has difficulties to model thresholds and context -> biodiversity, boundaries, social effects, ...**

- **These impacts are typically not considered (some developments of course)**

- **Traditionally, accidents, litter, grey economy are not considered either**

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LCA has still room for improvement - Modeling and method

- **LCA modelling (as we know:**
  - **Goal and scope**
  - **Foreground system of connected unit processes**
  - **Linked to background database**
  - **Impact assessment**
  - **Interpretation)**

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LCA has still room for improvement - Modeling and method

- **LCA modelling (as we know:**

  - **Foreground system of connected unit processes**
    - Modeling goes from one process to the next, following input products and output waste.

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LCA has still room for improvement - Modeling and method

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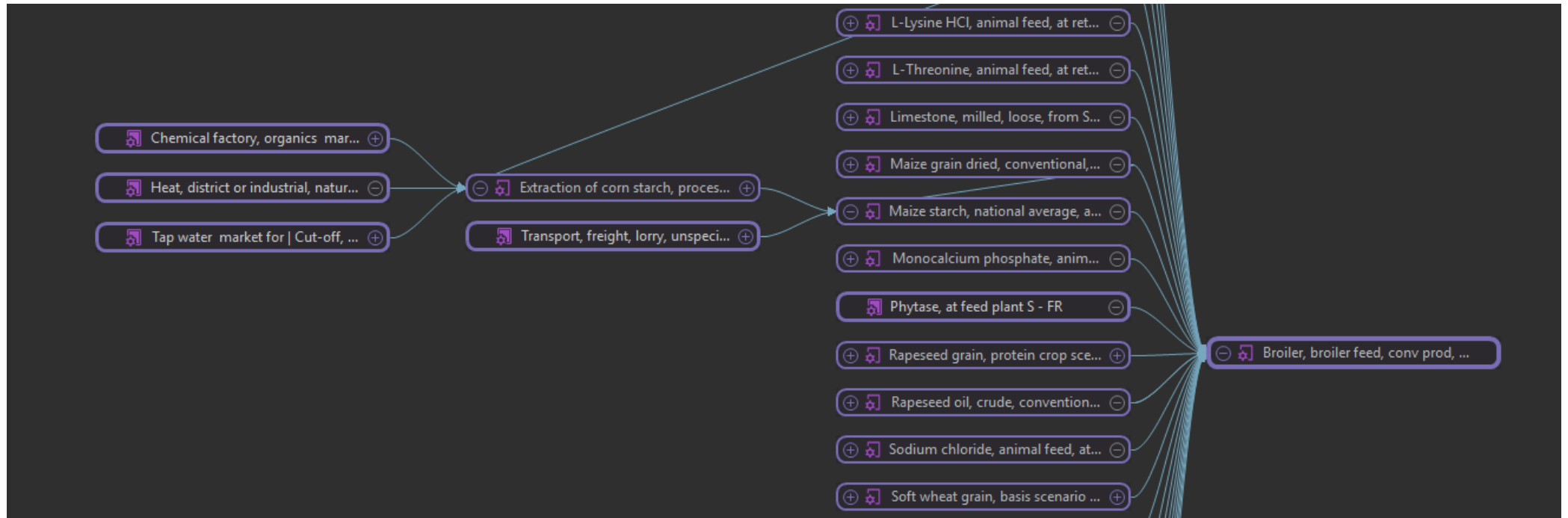
LCA has still room for improvement - Modeling and method

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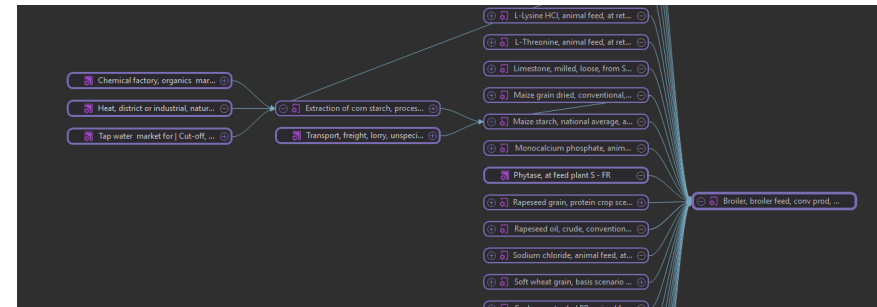
LCA has still room for improvement - Modeling and method

- **LCA modelling (as we know:**

  - **Foreground system of connected unit processes**
    - Modeling goes from one process to the next, following input products and output waste.

  This is similar to a frog perspective, and does not use system structure knowledge (!)

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LCA has still room for improvement - Modeling and method

- ## LCA frog perspective, simple example:

  **LCA of a comparison of granola vs. genetically modified (GM) granola; the GM granola uses fewer fertiliser. Everything else is identical in the model. Potential effect of GM organisms on nature is not considered.
  Result is..**

  Strange, Alison & Park, Julian & Bennett, Richard & Phipps, Richard. (2008). The Use of Life-Cycle Assessment to Evaluate the Environmental Impacts of Growing Genetically Modified, Nitrogen Use-Efficient Canola. Plant biotechnology journal. 6. 337-45. 10.1111/j.1467-7652.2008.00323.x.

The use of life-cycle assessment to evaluate the environmental impacts of growing genetically modified, nitrogen use-efficient canola

Alison Strange [1], Julian Park, Richard Bennett, Richard Phipps

Affiliations + expand

Abstract

Agriculture, particularly intensive crop production, makes a significant contribution to environmental pollution. A variety of canola (Brassica napus) has been genetically modified to enhance nitrogen use efficiency, effectively reducing the amount of fertilizer required for crop production. A partial life-cycle assessment adapted to crop production was used to assess the potential environmental impacts of growing genetically modified, nitrogen use-efficient (GMNUE) canola in North Dakota and Minnesota compared with a conventionally bred control variety. The analysis took into account the entire production system used to produce 1 tonne of canola. This comprised raw material extraction, processing and transportation, as well as all agricultural field operations. All emissions associated with the production of 1 tonne of canola were listed, aggregated and weighted in order to calculate the level of environmental impact. The findings show that there are a range of potential environmental benefits associated with growing GMNUE canola. These include reduced impacts on global warming, freshwater ecotoxicity, eutrophication and acidification. Given the large areas of canola grown in North America and, in particular, Canada, as well as the wide acceptance of genetically modified varieties in this area, there is the potential for GMNUE canola to reduce pollution from agriculture, with the largest reductions predicted to be in greenhouse gases and diffuse water pollution.

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# LCA has still room for improvement - Modeling and method

- ## LCA frog perspective, simple example:

  LCA of a comparison of granola vs. genetically modified (GM) granola; the GM granola uses fewer fertiliser. Everything else is identical in the model. Potential effect of GM organisms on nature is not considered.
  Result is
  – the GM granola has less potential impacts according to the LCA.

  Strange, Alison & Park, Julian & Bennett, Richard & Phipps, Richard. (2008). The Use of Life-Cycle Assessment to Evaluate the Environmental Impacts of Growing Genetically Modified, Nitrogen Use-Efficient Canola. Plant biotechnology journal. 6. 337-45. 10.1111/j.1467-7652.2008.00323.x.
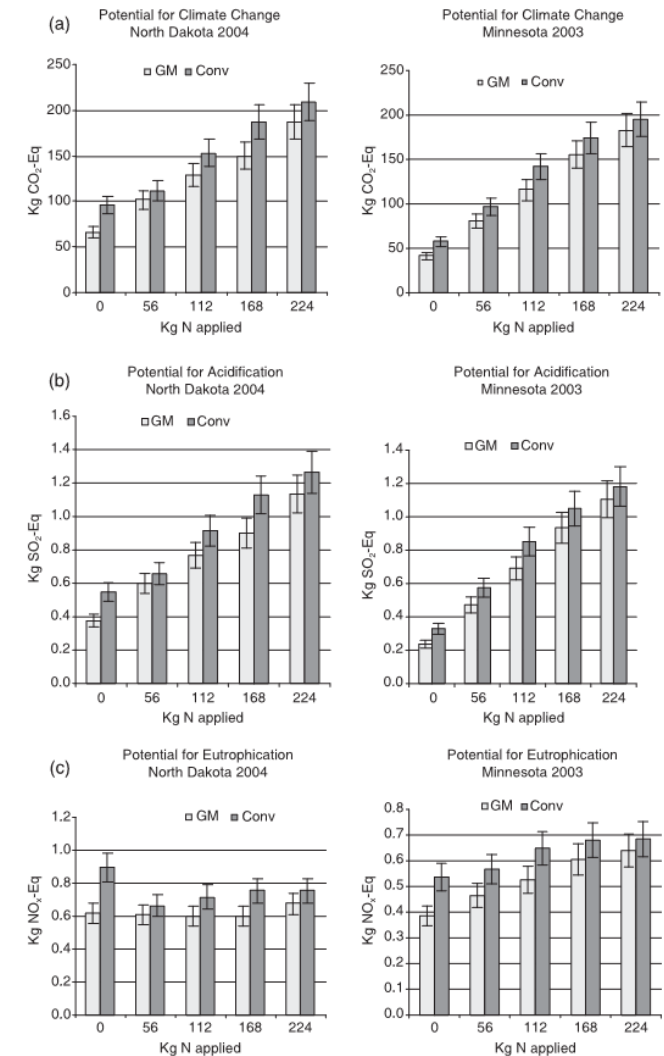
Our plans with openLCA

Our plans with openLCA

data	MSDB database
upscale and tool	openLCA ecosystem of tools
methodology	system dynamics models with LCA
	+ more outreach & communication

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Our plans with openLCA

data	MSDB database	see presentation the MSDB in comparison to other databases, database I session, 11th April
upscale and tool	openLCA ecosystem of tools	see presentation onlineLCA and others, in openLCA tools and integration II, 11th April
methodology	system dynamics models with LCA	see presentation Applying SDSA, in session broader sustainability assessments, 10th April
	+ more outreach	see last interactive session, April 11th

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Some conclusions

So, some conclusions

- LCA has seen an enourmous success in last 30+ years, and will be an important tool also in future

- It is always good to make LCA more effective and efficient, and I tried to list some aspects, linked to tools, data, method

- Maybe, now there is even more time to do so, to ensure a broad uptake and continuous use of LCA

- We are working on some things in this regard, but we cannot do this alone.

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So, some conclusions

- LCA has seen an enormous success in last 30+ years, and will be an important tool also in future

- It is always good to make LCA more effective and efficient, and I tried to list some aspects, linked to tools, data, method

- Maybe, now there is even more time to make LCA more effective and efficient, to ensure a broad uptake and continuous use of LCA

- We are working on some things in this regard, but **we cannot do this alone.**

So, some conclusions

- **We cannot do this alone.**

  -> we are increasingly reaching out and engaging in some networks

  -> please approach us with ideas, contributions, challenges

  -> maybe we can organise the openLCA users into a community.

  What do you think?

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Thank you very much!

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