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sustainability consulting + software

Working with multiple databases in one LCA software; interoperable databases, format conversion

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Integrating multiple databases in LCA software; interoperable databases, format conversion

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1 Integrating multiple databases in one LCA software

Integrating multiple databases in one LCA software

a) Challenges

Integrating multiple databases in one LCA software: Challenges

- Prepare software to work with the database
  - Size of the database, size of the LCA product system the database implies

    e.g., integration of ecoinvent 3 on a unit process level so far only done by SimaPro and openLCA, this was really some effort
  - Reflect specific model approaches where necessary

    e.g., integration of an EPD-type database such as the "Ökobaudat" in LCA software → EPD results are not LCA processes

Integrating multiple databases in one LCA software: Challenges

- Align the elements in the database with those existing already in the software
  - Map to reference lists
  - Expand the reference lists and include new elements

Aligning database reference elements

- Do this for
  - Flows
    - Elementary flows (CO_2 / carbon dioxide)
    - Product flows? Waste flows?
  - Categories and subcategories
    - Of elementary flows
    - For other flows?
  - Units, unit groups (“units of mass”, etc.)
  - LCIA methods and characterisation factors
  - Process data sets?

Aligning database reference elements

(Process data sets:

e.g., datasets from PlasticsEurope are part of GaBi databases, of the ELCD database, of ecoinvent, and PlasticsEurope is now an own node in the ILCD system; does it make sense to have then multiple versions in one software?

)

Aligning additional elements in databases

- Names for processes?
- Contacts
- Formulas used in process parameters?
- Metainformation, documentation
- ...

Integrating multiple databases in one LCA software

b) Experiences from openLCA and Nexus

openLCA

- openLCA is a free, fully featured, open source software for LCA and sustainability assessment developed by GreenDelta since 2006: www.openlca.org
- Created because we wanted to make the LCA approach better available (and professional LCA software is often too expensive), and we also wanted to make more modern LCA software available
- Increasingly used worldwide
- Contributions from EU 7th FP, US EPA, US DA, BMBF, JRC, PE, ecoinvent, PRé, PE, Fundacíon Chile, BASF... - thank you!

openLCA

- Licence sales of databases are an important part of the business model → we aim to make openLCA work with many different databases (also free databases)
- Recent developments:
  - Regionalised LCIA modeling
  - Performance and usability improvements
  - Non-expert user interface
  - Enterprise version

openLCA, performance

- From January 2014 – meanwhile slightly improved (beta 5 to be released next week)
- This shows also a relation between database and software

duration [seconds]	ecoinvent	openLCA 1.3.4	openLCA 1.4 beta 1	SimaPro 7.3.3	SimaPro 8.0.0
1 Creating a product system	2.2	19.14	5.20		
	3.0.1		17.25		
2 Opening an existing product system	2.2	12.89	2.89		
	3.0.1		3.52		
3 Calculating a product system, quick calculation	2.2	3.10	0.87		
	3.0.1		18.2		
4 Calculating a product system, analysis	2.2	17.30	4.32	12.55	11.80
	3.0.1		94.48		101.27

www.openlca.org/performance

openLCA, localised results

Locations

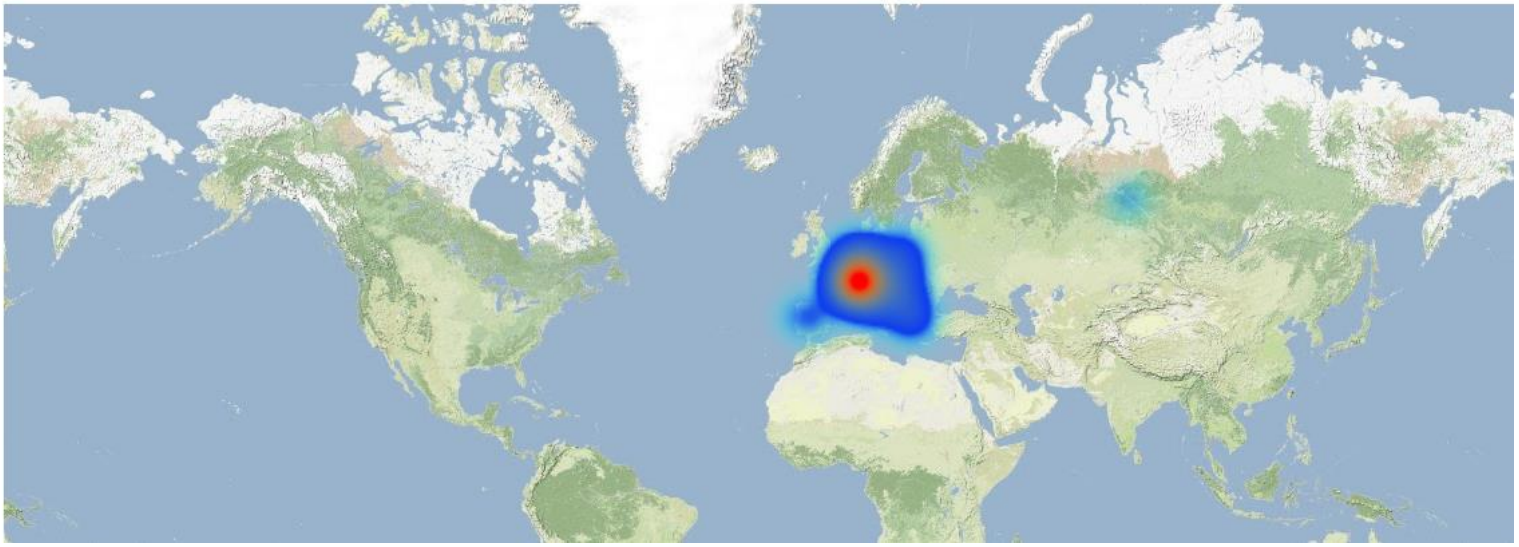
Flows: Tin, ion

Impact categories: marine aquatic ecotoxicity - MAETP 20a

Result contributions

Location	Amount	Unit
Global	5.51511E-9	
Switzerland	1.76272E-9	
Germany	2.55911E-10	
Poland	1.58618E-10	
Greece	1.39402E-10	
Italy	1.35375E-10	
Slovenia	8.82841E-11	

Map (beta)



Nexus

- Website that allows searching for, and downloading databases and data packs for openLCA: https://nexus.openlca.org/

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Nexus

- Nexus contains at present these databases

Dataprovider	
ecoinvent	14235
LC-Inventories.ch	6855
GaBi	6652
Social Hotspots	6356
Ökobaudat	954
ELCD	334
NEEDS	187
bioenergiedat	178

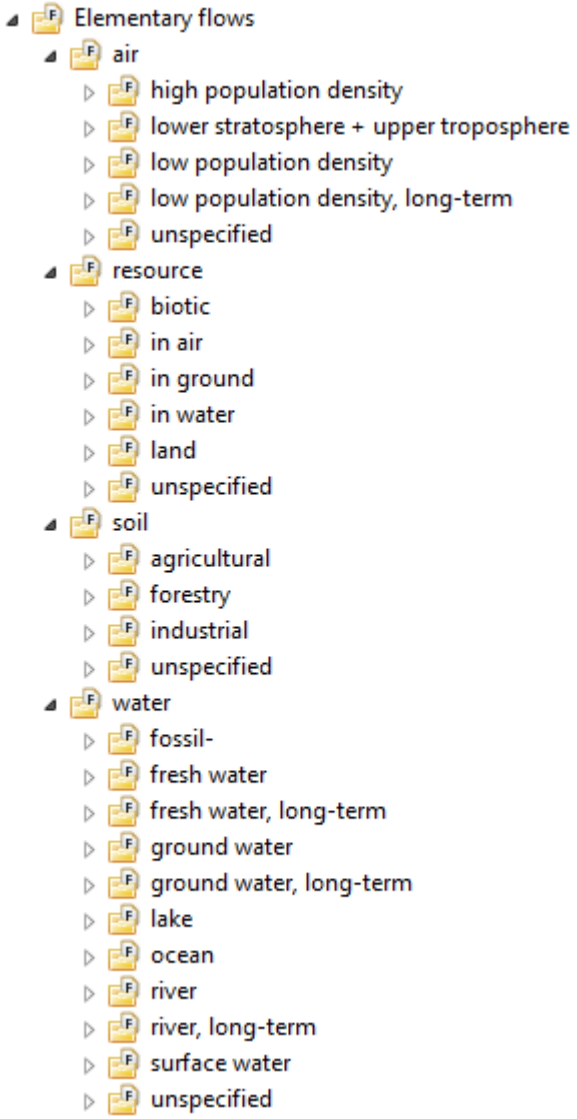
(ecoinvent 3.0.1; ELCD Version III; GaBi: Version 2013)

Nexus

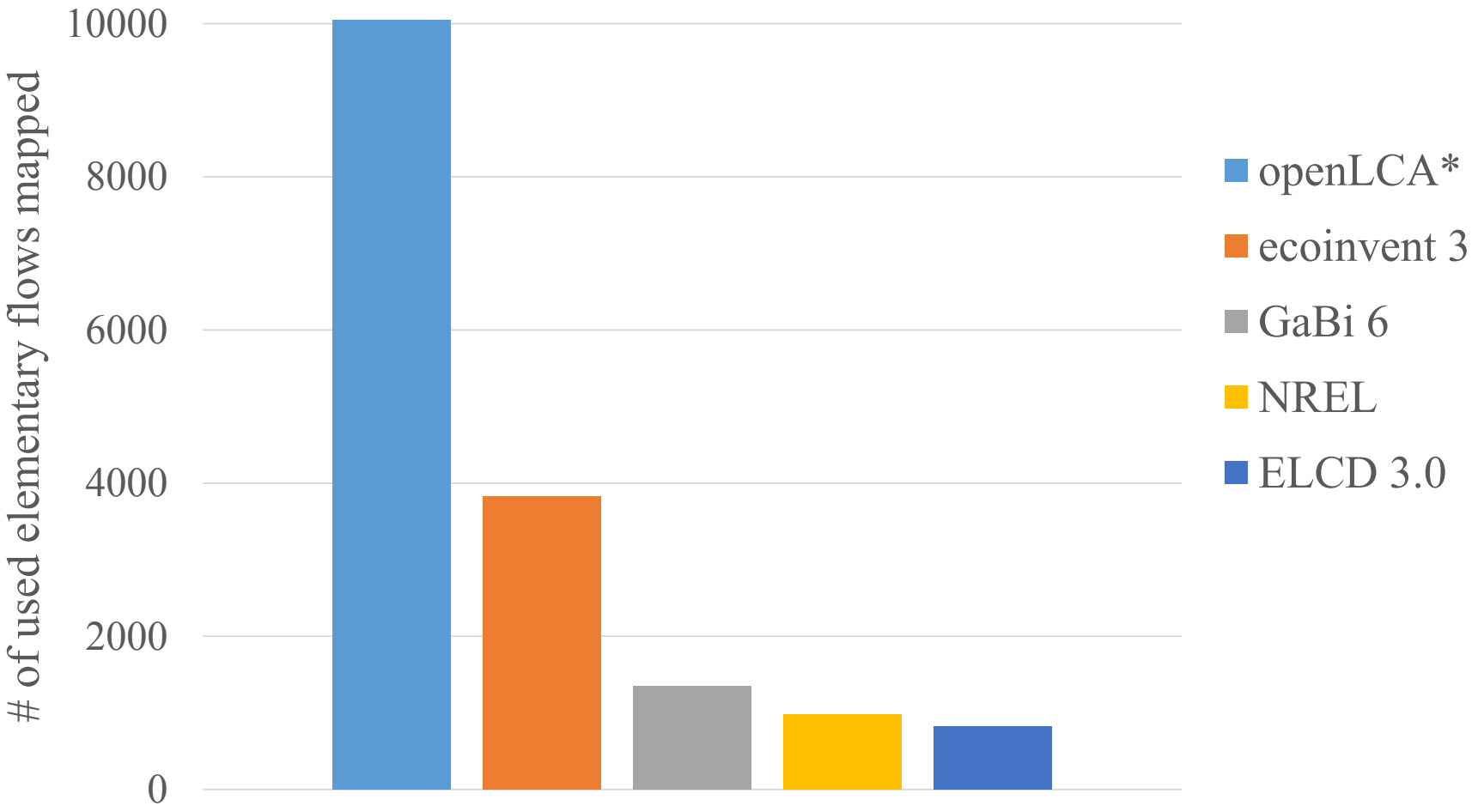
For integrating these different databases in one software, we created:

- A reference list of elements
  - Elementary flows
  - Elementary flow categories and subcategories
  - Units
  - Locations
  - …
- A mapping of these elements to all elements in the nexus-databases

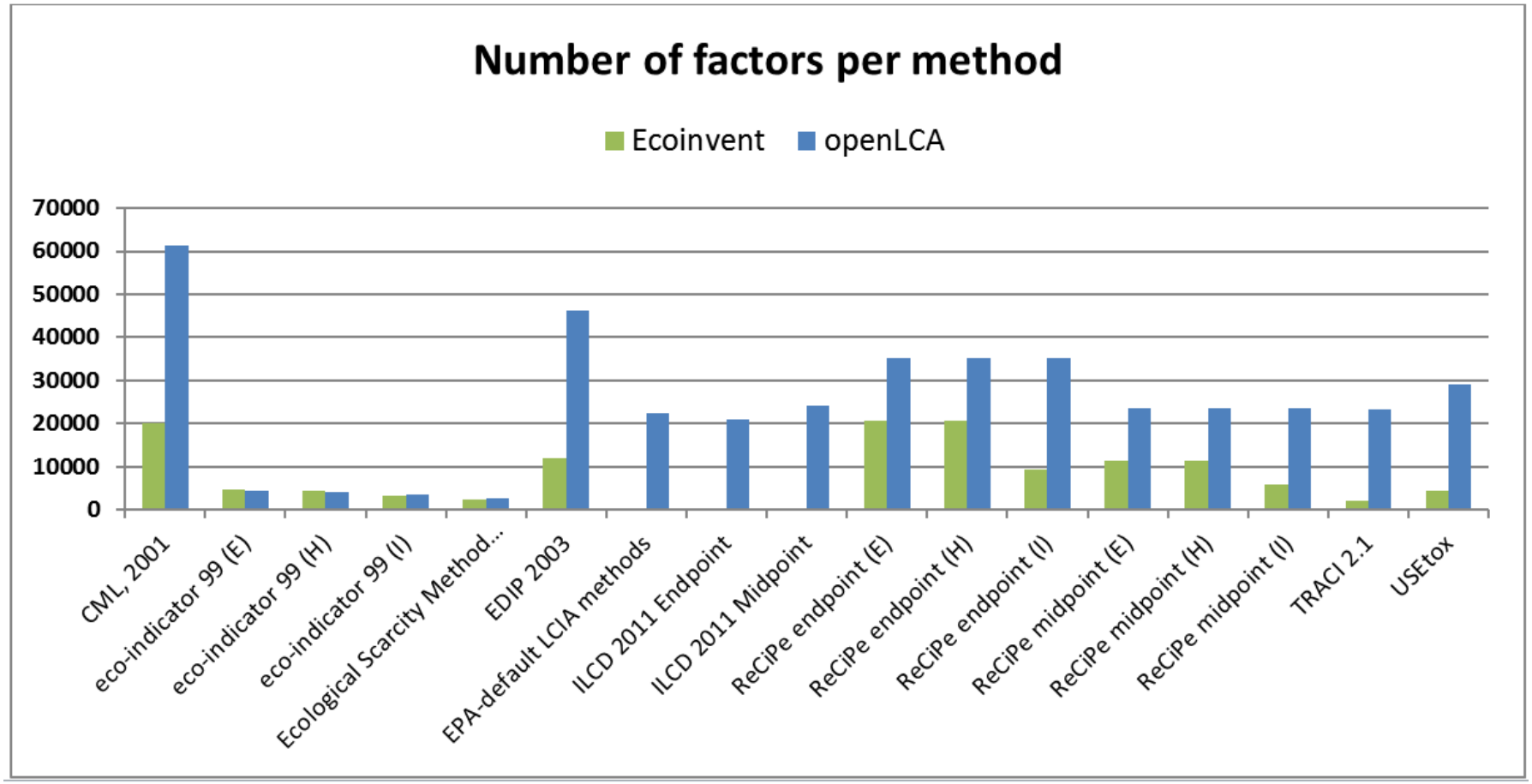
Nexus, reference example: categories and subcategories



Nexus, reference example: elementary flows



Nexus, reference example: Characterisation factors



Examples for refactoring of datasets

e.g. GaBi data sets

- Processes with same flow as input and output modified
- Some reference products adapted to openLCA current requirements (i.e. output product flows)
- Some product flows remodeled to waste flows

Outputs

Flow	Category	Flow property	Unit	Resulting amount	Uncertainty	Avoided product?	Pedi
Halon-1001	**Valuable substances / Materials**	**Mass**	**kg**	**1**	**No distri...**	☐	
Tailings (deposited)	Deposited goods / Stockpile goods	Mass	kg	-4.18882957047...	No distrib...		
Overburden (deposite...	Deposited goods / Stockpile goods	Mass	kg	2.63863453883204	No distrib...		
Radioactive tailings	Deposited goods / Radioactive waste	Mass	kg	6.889974087663...	No distrib...		
Medium radioactive ...	Deposited goods / Radioactive waste	Mass	kg	7.307919782632...	No distrib...		
High radioactive waste	Deposited goods / Radioactive waste	Mass	kg	8.910596657611...	No distrib...		

Examples for combining different databases in LCA software

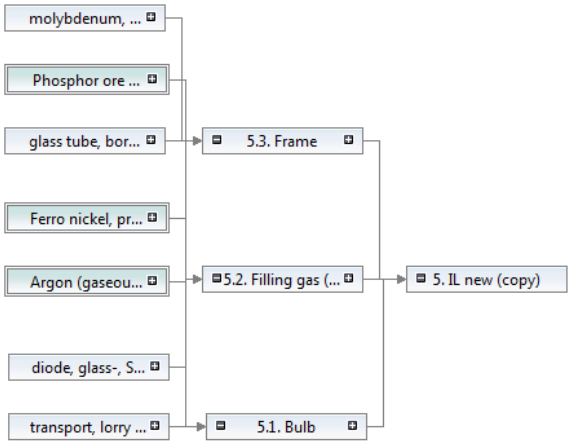
Apart from the details of data adaptation and alignment: it works (to a reasonable extent):

Case study for a lamp system using GaBi databases and ecoinvent databases, with specific data, and complementing with generic data

a) starting from GaBi processes and
b) starting from ecoinvent processes

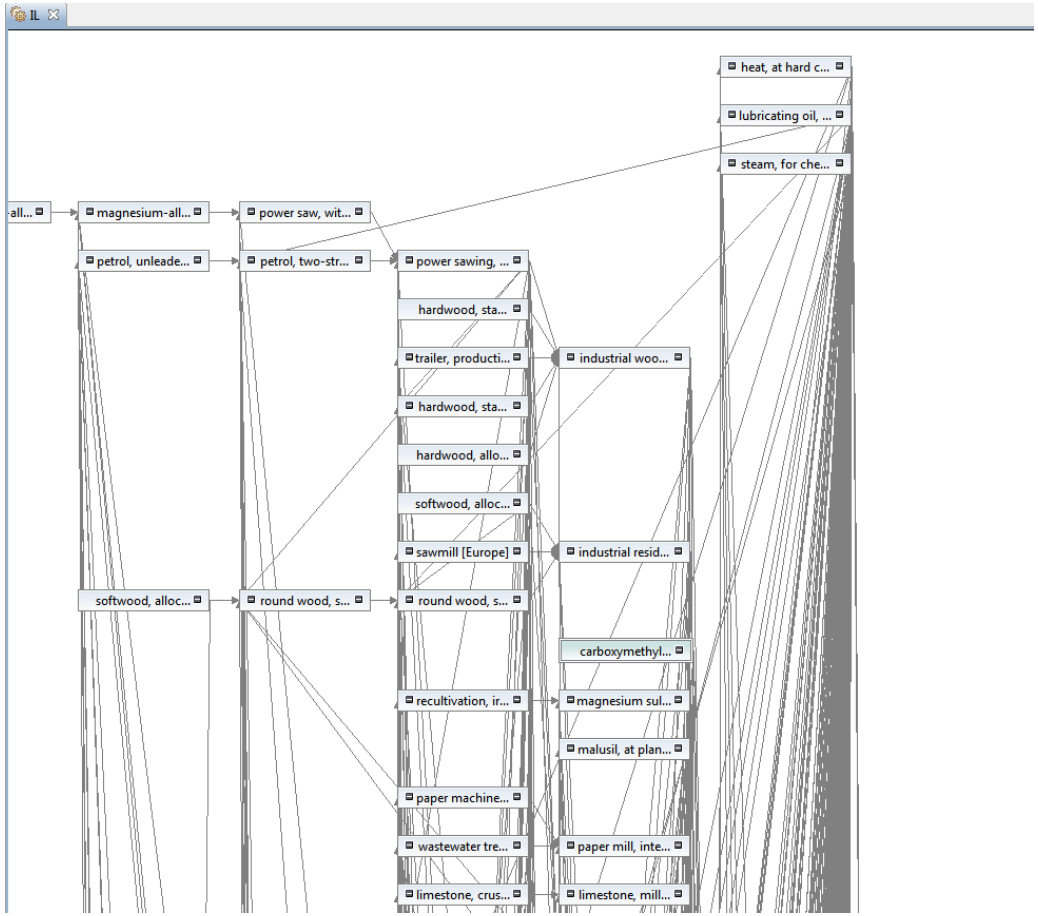
Examples for combining different databases in LCA software: Incandescent Lamps

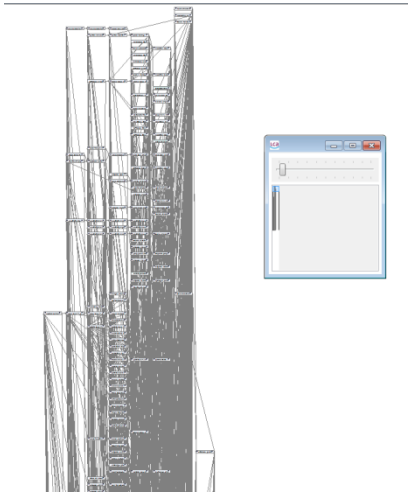
a) “ecoinvent-enriched” GaBi



Examples for combining different databases in LCA software: Incandescent Lamps

b) “GaBi-enriched” ecoinvent





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Examples for combining different databases in LCA software

→ Modeling is typically different, models look very differently;

→ comparison results are here (specific case: GaBi, ecoinvent, lamp comparison, CML as LCIA method)

- Stable for main categories (GWP, AP, EP);
- Very different for toxicity categories, GaBi has much lower contributions

(But for openLCA: users can decide to work only with GaBi databases, or only with ecoinvent databases)

2 Towards interoperable databases

Towards interoperable databases

Two extreme approaches:

a) GiSo: Garbage in, sense out. With a smart technology, any data sources can be converted into meaningful LCA information and data sets

b) Perpetuum mobile: If only everyone fully sticks to the same requirements, then all data sets and databases are consistent
(→ superconduction...)

(Of course, two extreme approaches that do not exist)

Towards interoperable databases

Best of both approaches:

- Basic, core requirements that databases have to fulfill;
- These requirements are specified and ideally internationally agreed upon
- Smart technology is used for transforming data from a data pool into one or the other more specific application, with more detailed requirements

Towards interoperable databases

Best of both approaches, continued:

- Rules applied in the technology are also agreed upon and need to be developed and evaluated by experts
- This technology will not be perfectly working for all cases
  → databases should provide a documentation/meta information for which specific application they can be used; ideally on the data set level, in a machine-readable way.

3 Format conversion

Format conversion (only shortly)

Format conversion is one part in the technology portfolio to make databases interoperable, but there are more.

openLCA format converter reference for converting LCA data formats; now ongoing project with JRC to include it in the ELCD network and to improve the conversion.

Format conversion does (usually) not change the content of data sets (e.g., adding toxicity flows that have not been included), which is sometimes required for consistent data sets.

Format conversion (only shortly)

Format conversion is (with considerable effort) fully possible, apart from two main points:

a) Unresolvable items:

source	target
resource unspecified	resource in water
	resource in air
	resource in ground
	resource in land

b) Undocumented deviations from a format

quite frequent, also e.g. the ecoinvent database does not always follow the EcoSpold2 specification but has introduced new values for fields e.g.; the ELCD database misses several flow property data sets, ...

4 Conclusions, wish list

Conclusions

- Working with different databases in LCA software works but has challenges
- Database interoperability is “in its infancy” still today
- Policy and stakeholder input needed for
  - Basic principles
  - Should a specific database at all be used in a different context? Should it be interoperable? Is interoperability at all desired?
- Technical expert and technology input required to overcome barriers on a detailed level
- The nexus reference system can be used as a starting point, being the most advanced and comprehensive today (as far as I know)

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Thank you!

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