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sustainability consulting + software

ecoinvent 3 in openLCA

Ecoinvent 3 from the point of view of a software provider

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GreenDelta Berlin

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ecoinvent 3 in openLCA

1 Introduction

- **a) ecoinvent 3**
- **b) openLCA**

2 Implementation tasks for openLCA, due to ecoinvent

3 ecoinvent 3 in openLCA: status at present

4 Discussion

1 Introduction

1 Introduction, ecoinvent 3

(just some points)

1 Introduction, ecoinvent 3

Ecoinvent 3 brings

- A new, feature-rich data format, EcoSpold02
  - According to a final format specification
  - Formulas, parameters, multiple languages, own intelligence, child-parent relationships in LCA datasets,
  - New reference lists for flows, asf., now with UUIDs
  - …
- An interpretation of the data format EcoSpold02 data format for ecoinvent 3 data sets
  - Usually of course following the specification but some modifications and additions
  - Important for the implementation

1 Introduction, ecoinvent 3

Ecoinvent 3 brings

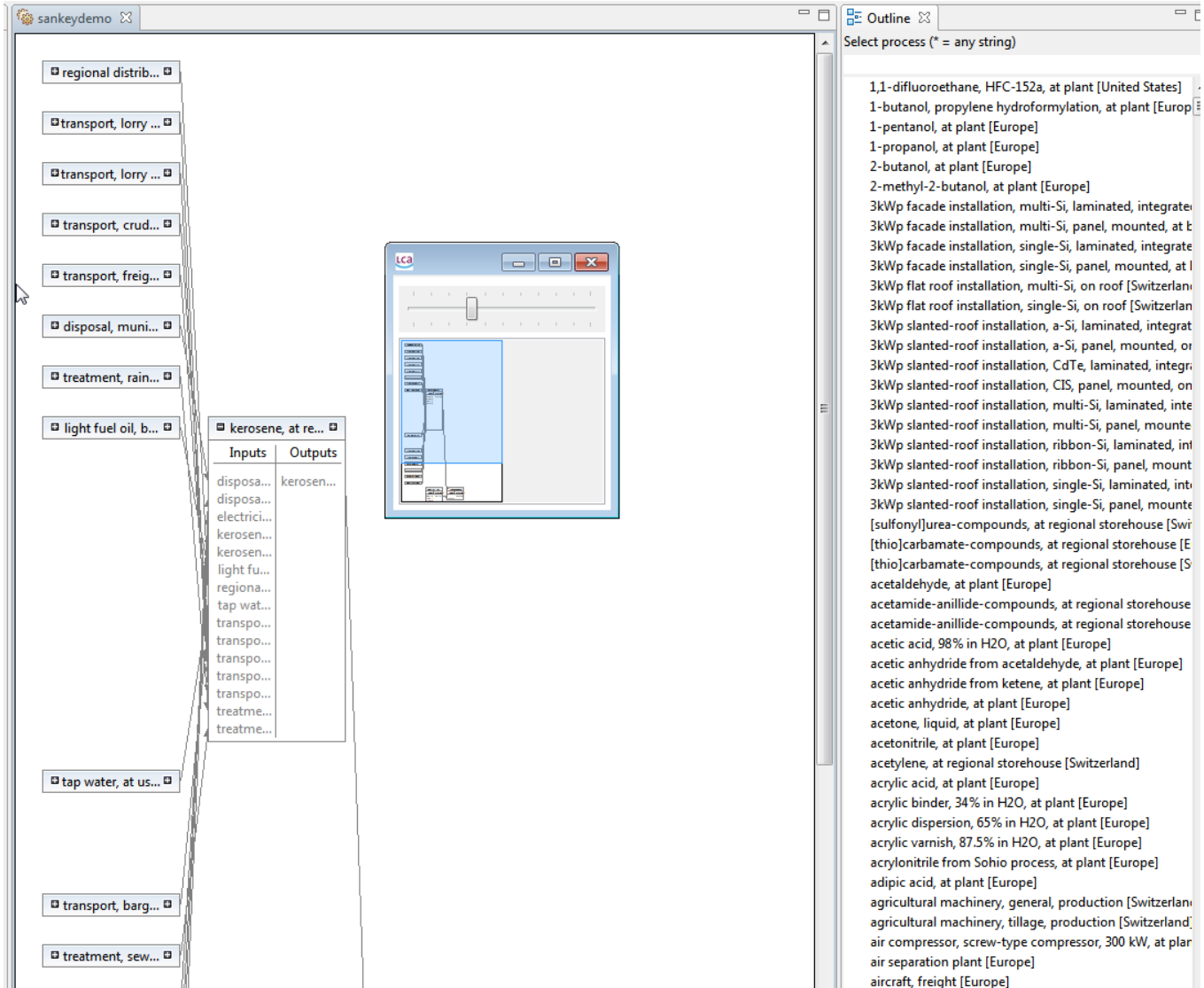
- New types of process data sets, for markets, that typically link one process with another

→ a drastically increased number of data sets in one typical product system (with the same number of LCA process data sets).

openLCA

- Professional open source LCA software, free
- Developed by GreenDelta since 2006
- So far we are the only developer but currently several projects started, e.g.by US EPA, to develop additional content
- Quite popular, worldwide, with 300 downloads / week
- Users: many universities, consultants, US EPA and other research institutes, first companies
- Last release: version 1.3.1, 28 Sept 13
- www.openlca.org

openLCA – graphical modeling



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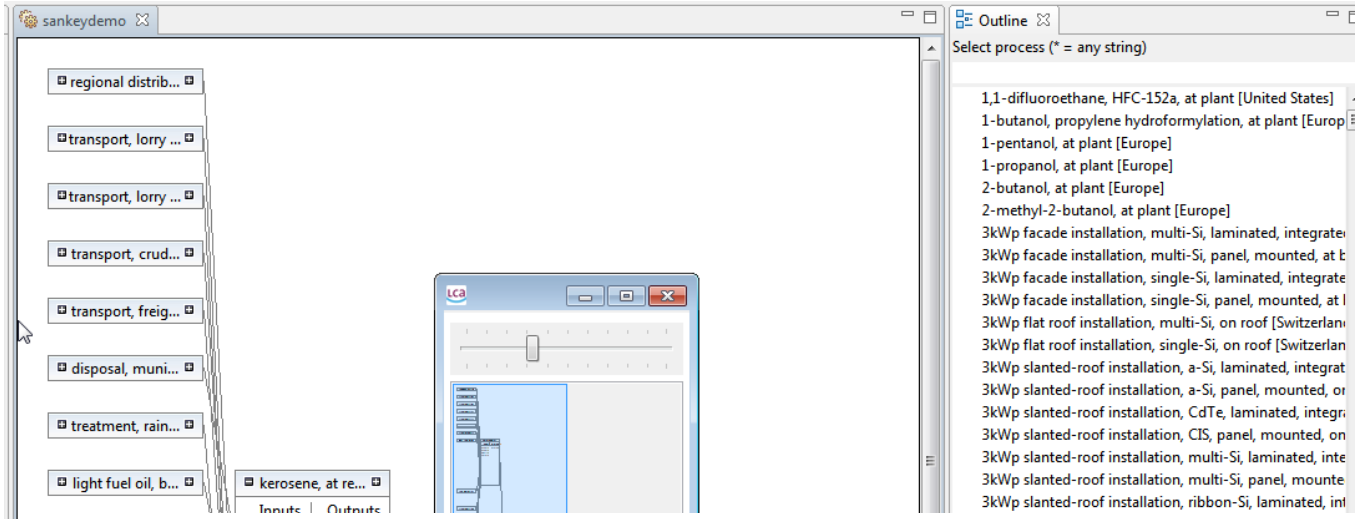
openLCA – graphical modeling



- And also automatic completion of product systems for a calculation, similar to e.g. SimaPro

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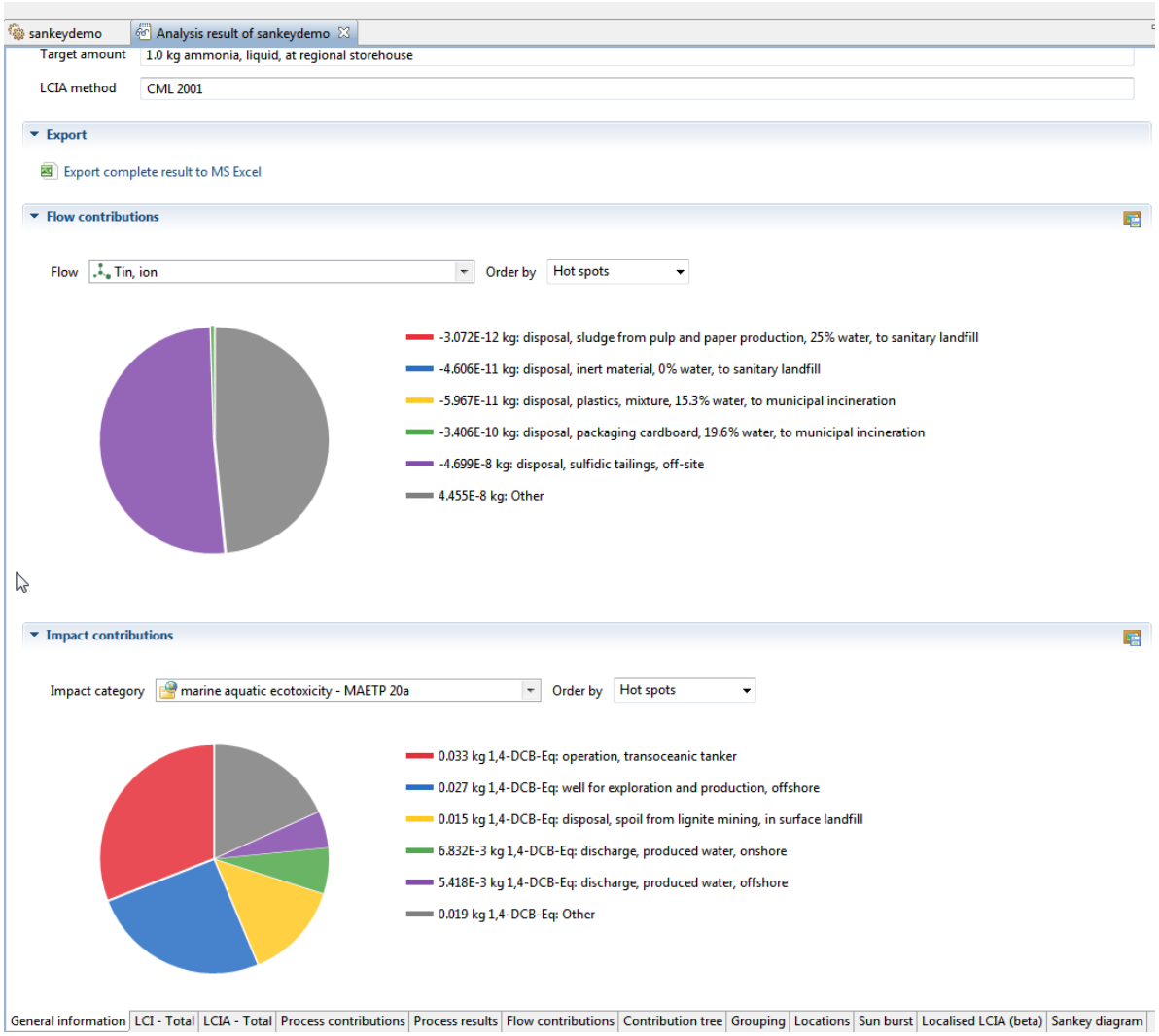
openLCA – analysis features



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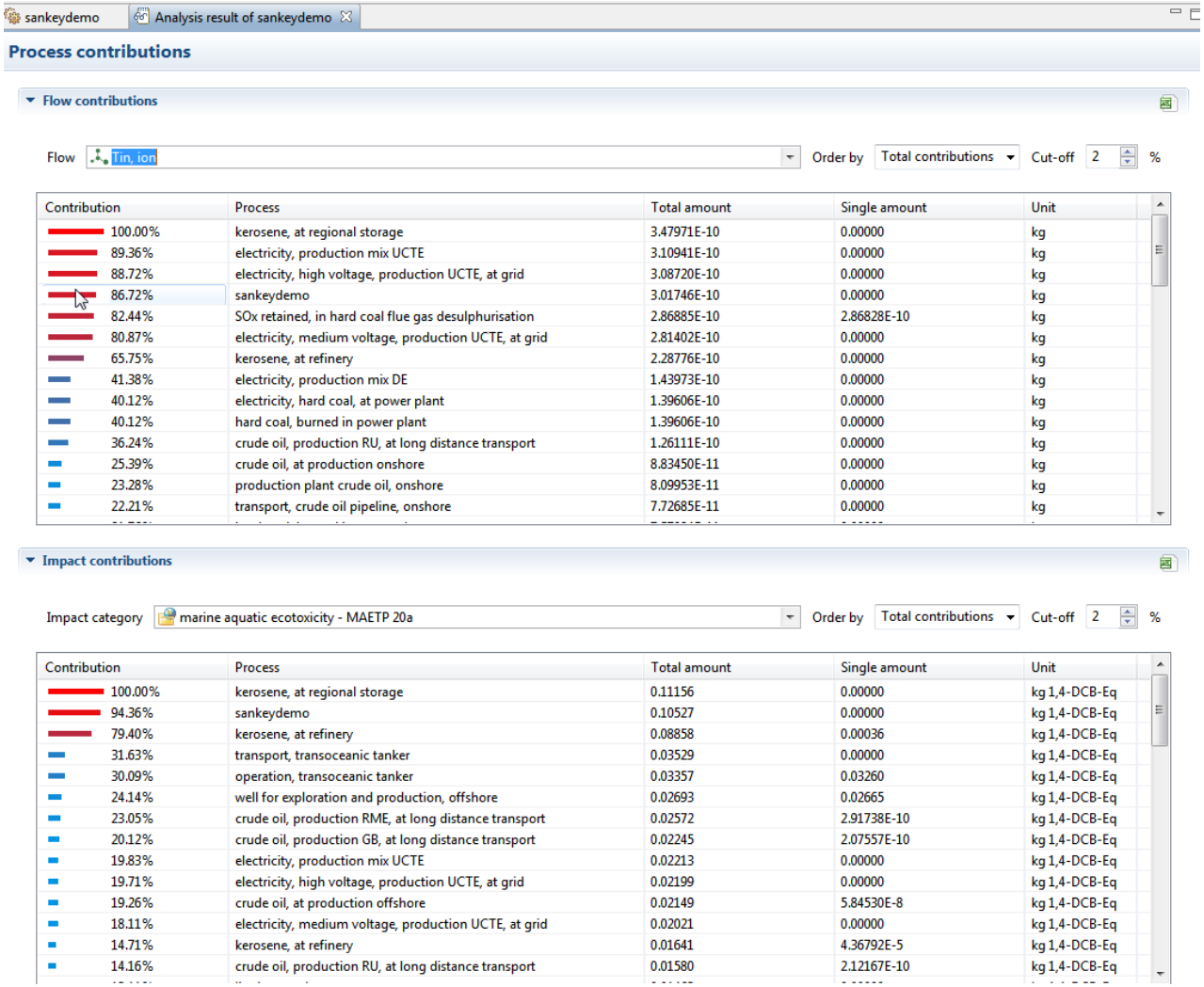
openLCA – analysis features



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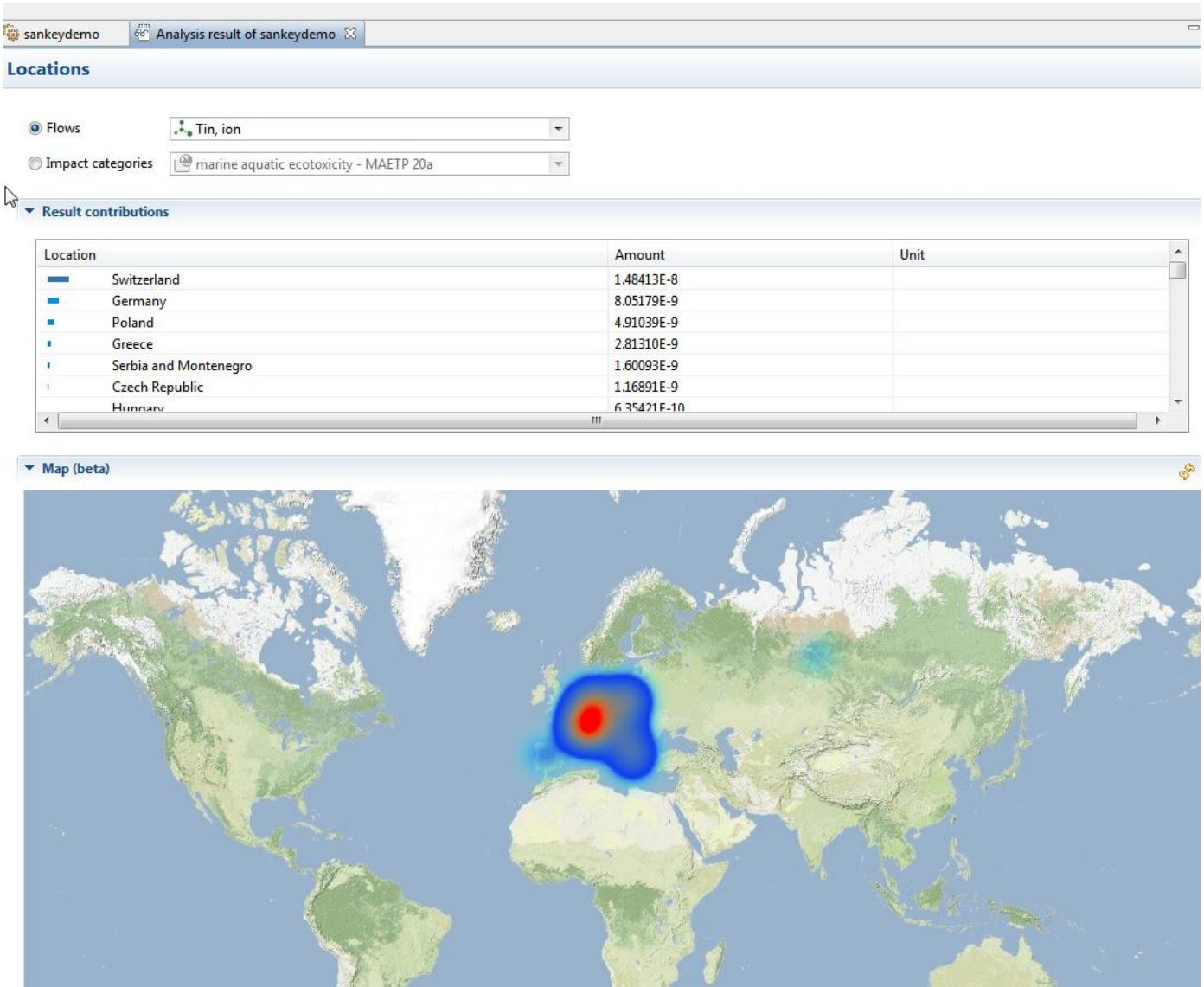
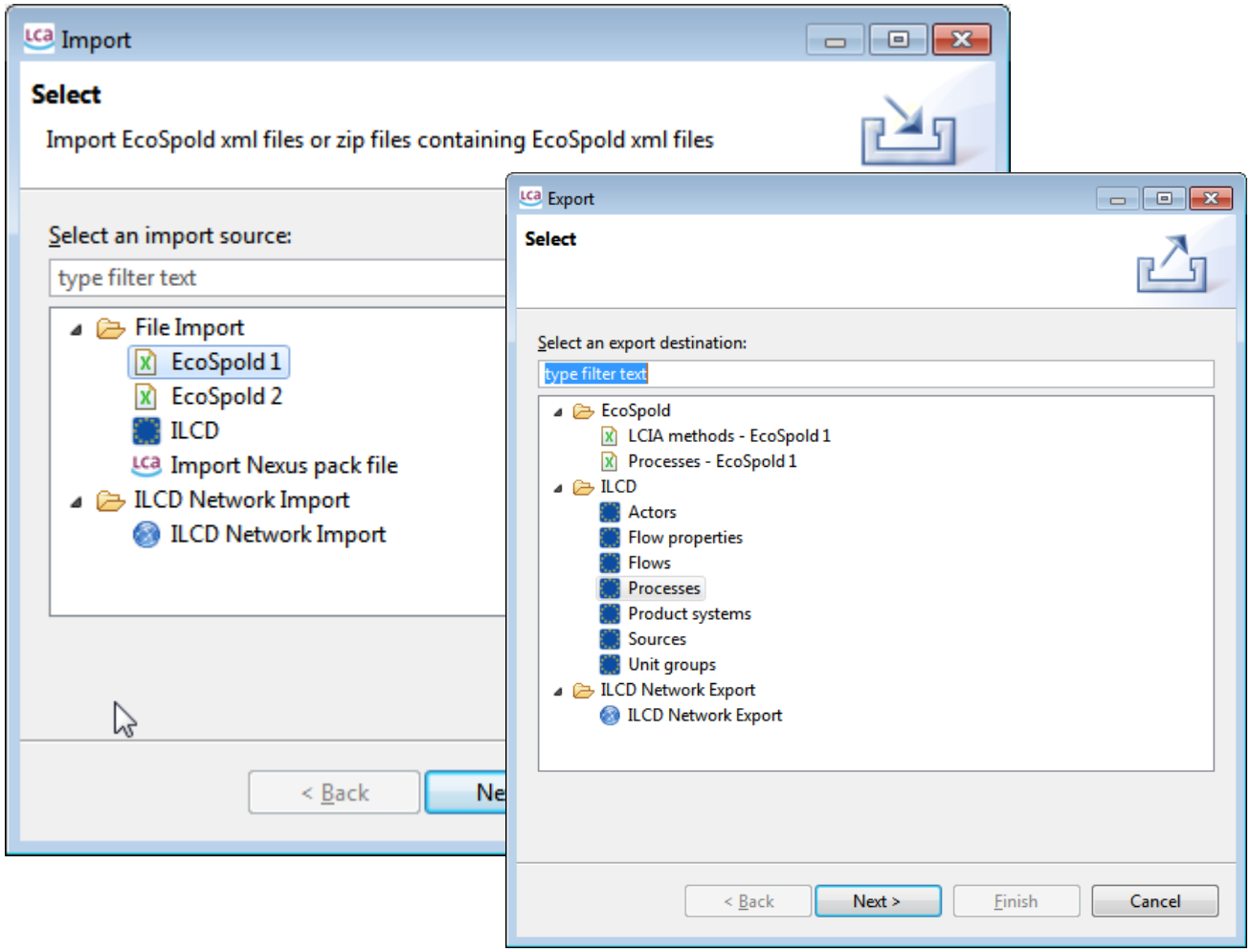
openLCA – analysis features



openLCA

- Broad import and export features:



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openLCA

- Many databases supported, including:
  - Ecoinvent
  - Other databases in EcoSpold 1 format, as NREL
  - All GaBi databases
  - Social Hot Spots Database (SHDB)
  - Ökobaudat
  - …

Database provider

GaBi 6544
Social Hotspots 6356
ecoinvent 4087
Ökobaudat 972
ELCD 272
NEEDS 187
bioenergiedat 178

2 Implementation tasks for openLCA suggested by ecoinvent 3

3 Implementation tasks for openLCA, due to ecoinvent

(first task: *Understand* the EcoSpold02 format and its interpretation in the ecoinvent 3 database:

- not all features are used in ecoinvent
- some features address issues that can be solved rather internally in a software than in an data exchange format (parent child datasets)
- The ecoinvent database uses additional tricks that need to be addressed
- (revisions on the ecoinvent side – a bit of a moving target)

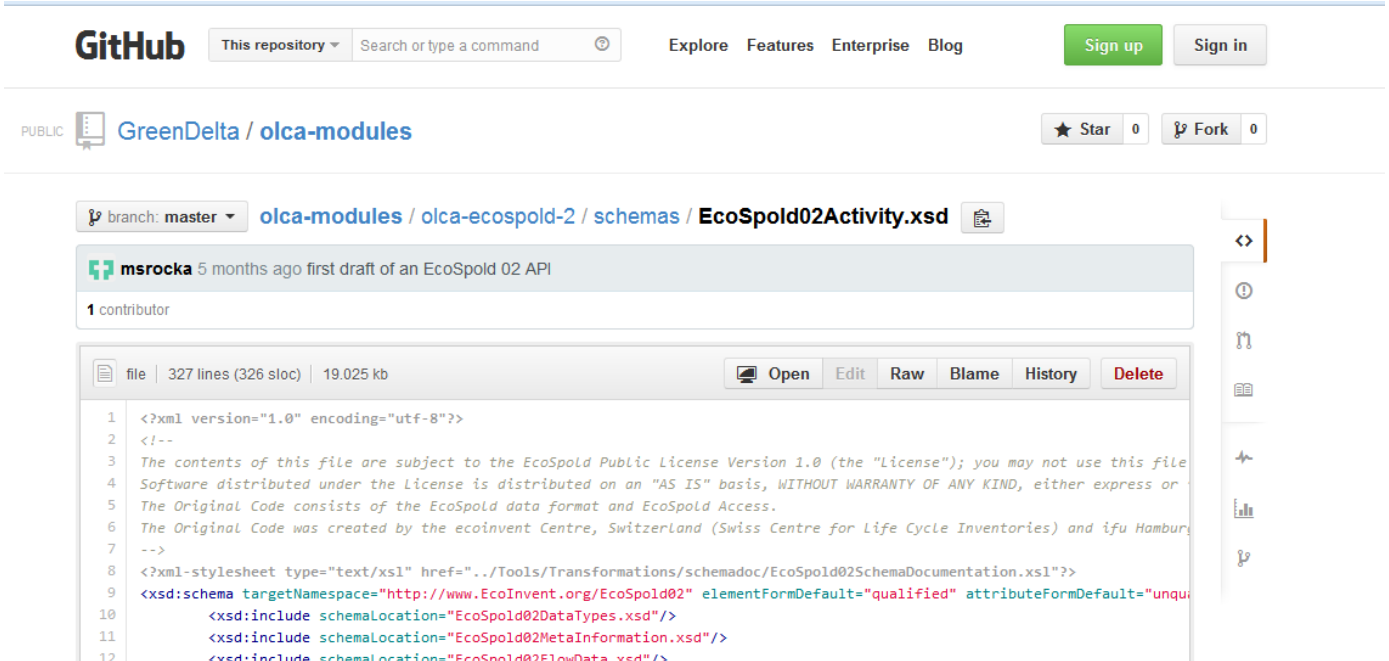
)

3 Implementation tasks for openLCA, due to ecoinvent

- Implementation of an EcoSpold 02 interface (for import and export)
- Reduction of memory space requirements
- Faster loading of product systems
- Faster calculation
- (improved treatment of parameters)

EcoSpold 02 interface

- Format specification as available in our github repository: https://github.com/GreenDelta/olca-modules/blob/master/olca-ecospold-2/schemas/EcoSpold02Activity.xsd



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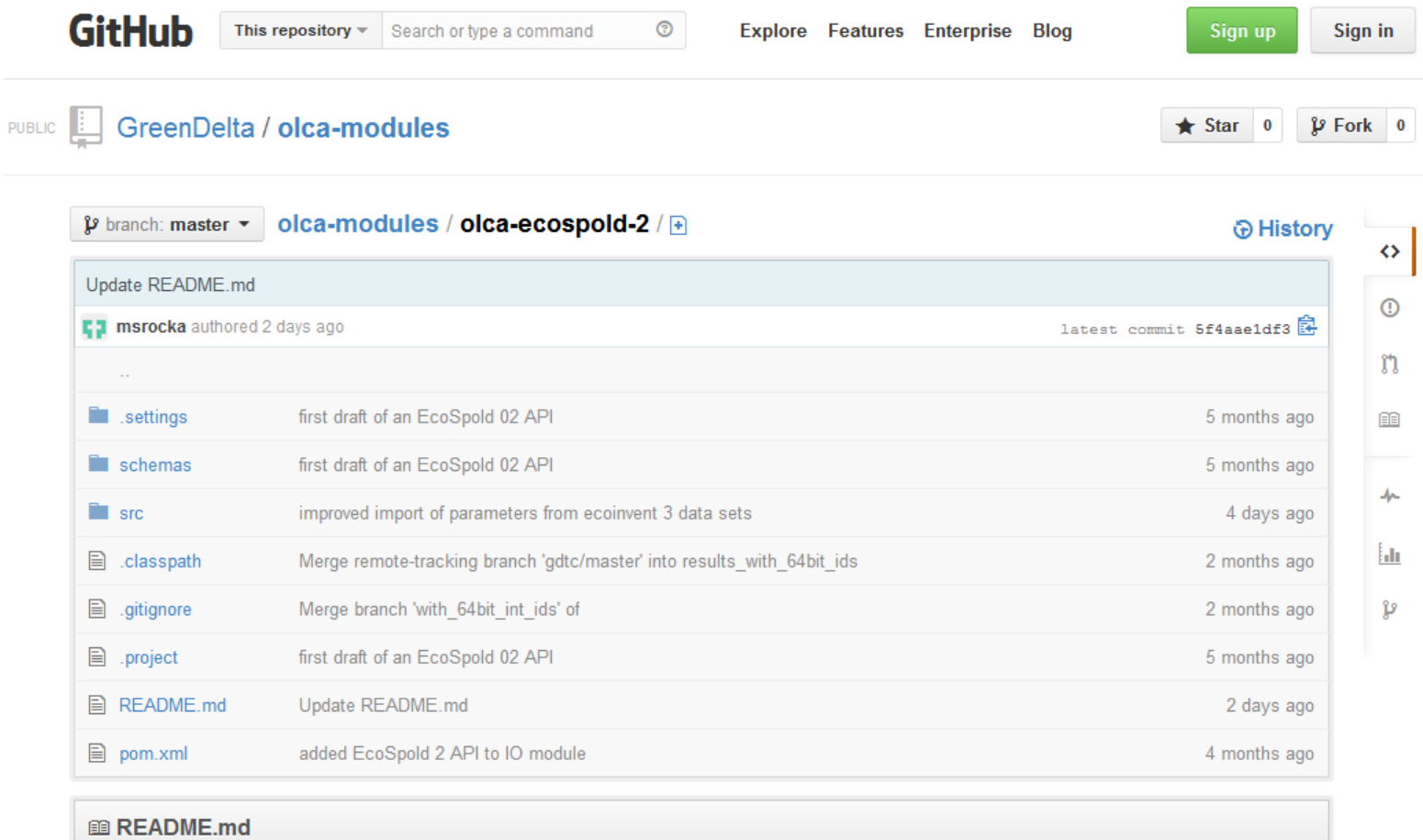
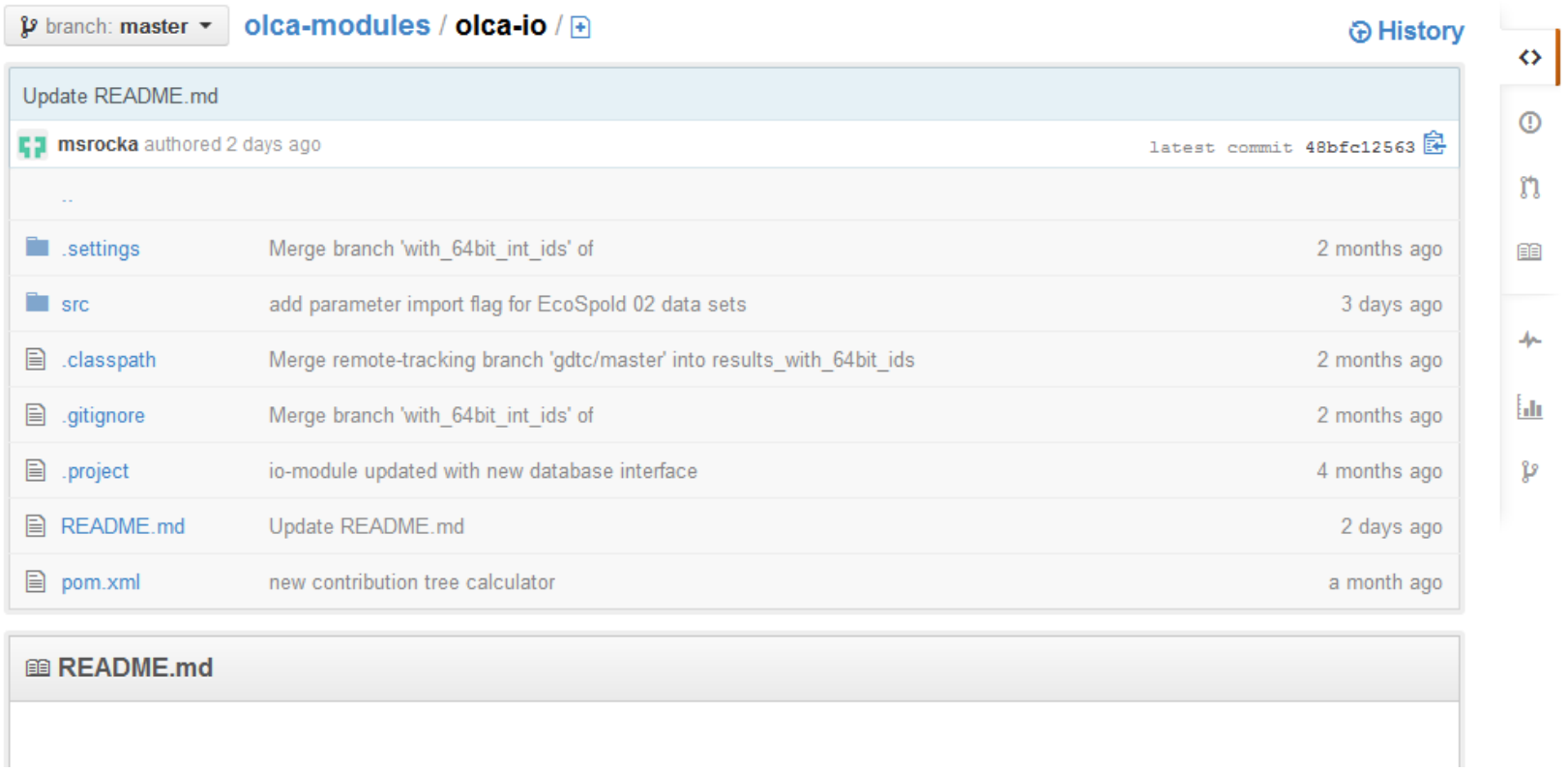
EcoSpold 02 interface

- API created to import and export EcoSpold02



EcoSpold 02 interface

- olca-io created to map the format to the database



EcoSpold02 interface: noteworthy

- ActivityLink – Default provider structure: in openLCA since 1.2.9
  → fits nicely
- Flow properties (water content etc.): in ecoinvent linked to an exchange, in openLCA and ILCD linked to a flow → □
- Waste is a negatic amount in ecoinvent 3
  → change input and output in openLCA → fine
- No unit groups in ecoinvent 3
  → direct mapping to openLCA units → fine.
- Allokation factors of migrated ecoinvent 2 activities are flow properties, „EcoSpold01Allocation_undefined_XY“
  → these cannot be used in a reasonable way any more?
- Parameters: Formulas contain often hard links to specific computer hard drives → ?
- Master data often saved also in process data sets, redundantly
  → risk of inconsistencies

```
    <outputGroup>2</outputGroup>CRLF
</intermediateExchange>CRLF
<intermediateExchange id="eb369ed2-ccf9-449f-b7ff-3a1eda104871" unitId="487df68b-4994-4027-8fdc-a[illegible]dc298257b7" amount="0" in
    <name xml:lang="en">palladium</name>CRLF
    <unitName xml:lang="en">kg</unitName>CRLF
    <property propertyId="40ca2c51-2da6-4351-bd4c-d6f181fc7d55" amount="37.91">CRLF
      <name xml:lang="en">EcoSpold01Allocation_undefined_2</name>CRLF
    </property>CRLF
    <property propertyId="13706ab5-1a8c-42fd-8329-c93266943c87" amount="37.91">CRLF
      <name xml:lang="en">EcoSpold01Allocation_undefined_16</name>CRLF
    </property>CRLF
    <property propertyId="db2e27d1-47cd-4180-8416-4f79369de00c" amount="37.91">CRLF
      <name xml:lang="en">EcoSpold01Allocation_undefined_6</name>CRLF
    </property>CRLF
    <property propertyId="3db02346-808f-4eb6-9232-317a23c63484" amount="37.91">CRLF
      <name xml:lang="en">EcoSpold01Allocation_undefined_7</name>CRLF
    </property>CRLF
    <property propertyId="9909d836-d0a3-45ed-a8d6-62f5febc763e" amount="100">CRLF
      <name xml:lang="en">EcoSpold01Allocation_undefined_21</name>CRLF
    </property>CRLF
    <property propertyId="9c38ea07-adcd-4018-8636-eb32382f39a7" amount="37.91">CRLF
      <name xml:lang="en">EcoSpold01Allocation_undefined_5</name>CRLF
    </property>CRLF
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    </property>CRLF
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    </property>CRLF
    <property propertyId="a9358458-9724-4f03-b622-106eda248916" amount="0" unitId="577e242a-461f-44a7-922c-d8e1c3d2bf45">CRLF
      <name xml:lang="en">water content</name>CRLF
      <unitName xml:lang="en">dimensionless</unitName>CRLF
```
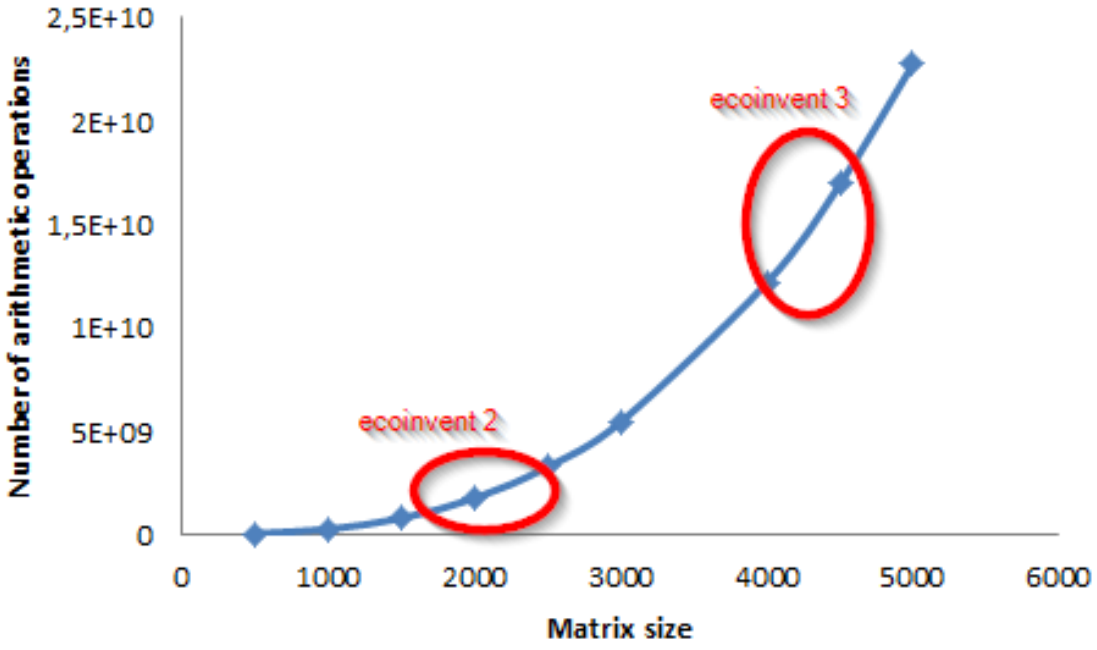

```
          <comment xml:lang="en">calculated from mass balance</comment>
        </uncertainty>
        <property propertyId="335fb25a-49eb-4a6c-8c28-9a19d16c9456" variableName="amount_ash_calc_prop_kg"
amount="0.00748" isDefiningValue="false" mathematicalRelation="LiveLink('C:\Documents and Settings\treyer_k\My
Documents\ecoinvent\EcoEditor\LiveLinks\electricity production hard coal LiveLinks.xls','Sheet1','C19','',
'Automatic')" isCalculatedAmount="true" unitId="487df68b-4994-4027-8fdc-a4dc298257b7" sourceId="6ad10bdb-
b629-4991-94a9-478b752cde90" sourceYear="2007" sourceFirstAuthor="Röder, A.">
          <name xml:lang="en">calculation property, kg</name>
```

activity id="b46483cf-6b87-4898-9f8e-004dd13c4c76“, ecoinvent 3.0.1
(just one example)

Memory space requirements

- Issue: Memory space requirements in a matrix calculation is $\sim O(n^3)$ → cubic increase with the number of data sets

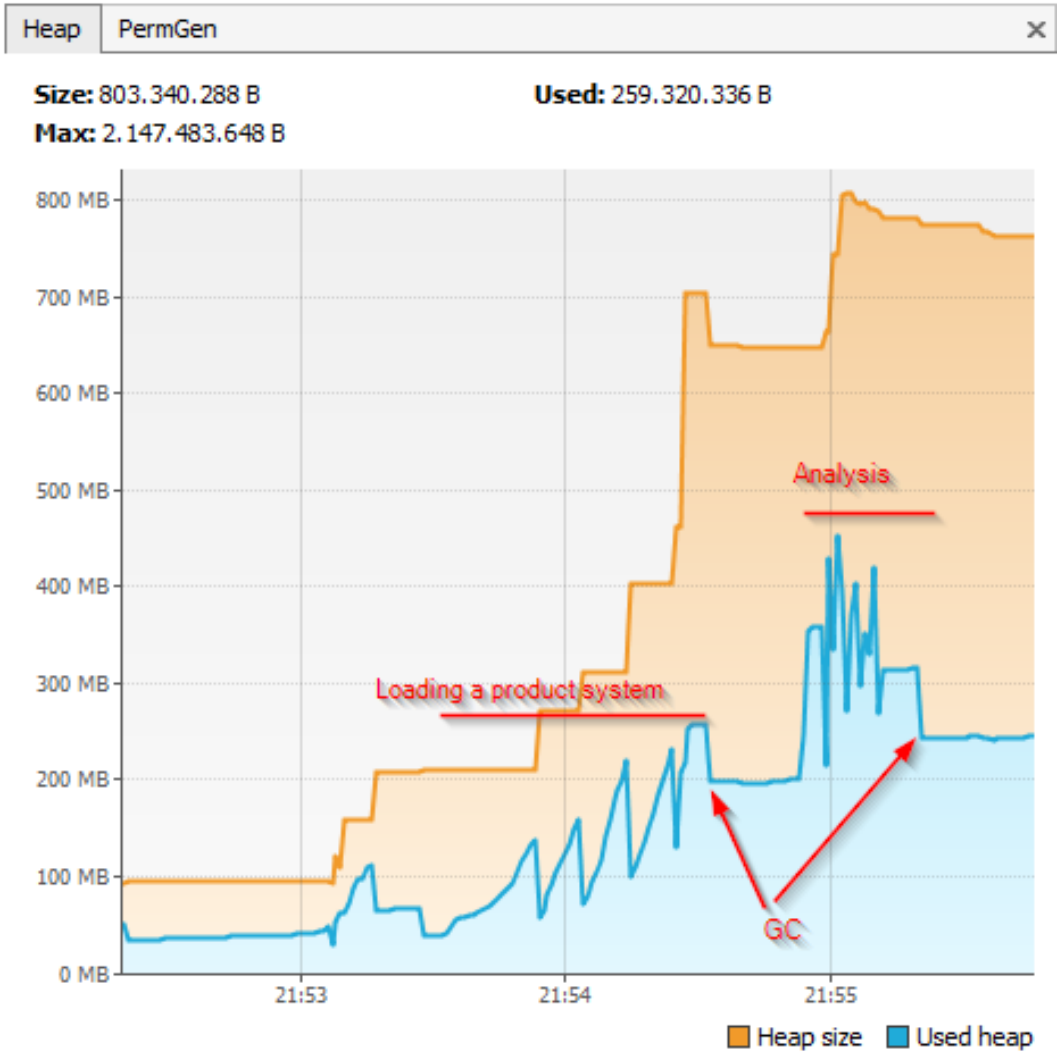


Memory space requirements

- Issue: Memory space requirements in a matrix calculation is $\sim O(n^3)$ → cubic increase with the number of data sets

→ Stick to matrix calculation but make element loading and calculation more efficient

Memory space requirements, example: Loading and analysing a product system, ei2



openLCA 1.3:

Product system open:

200 MB

Analysis peak:

450 MB

Product system & result open:

250 MB

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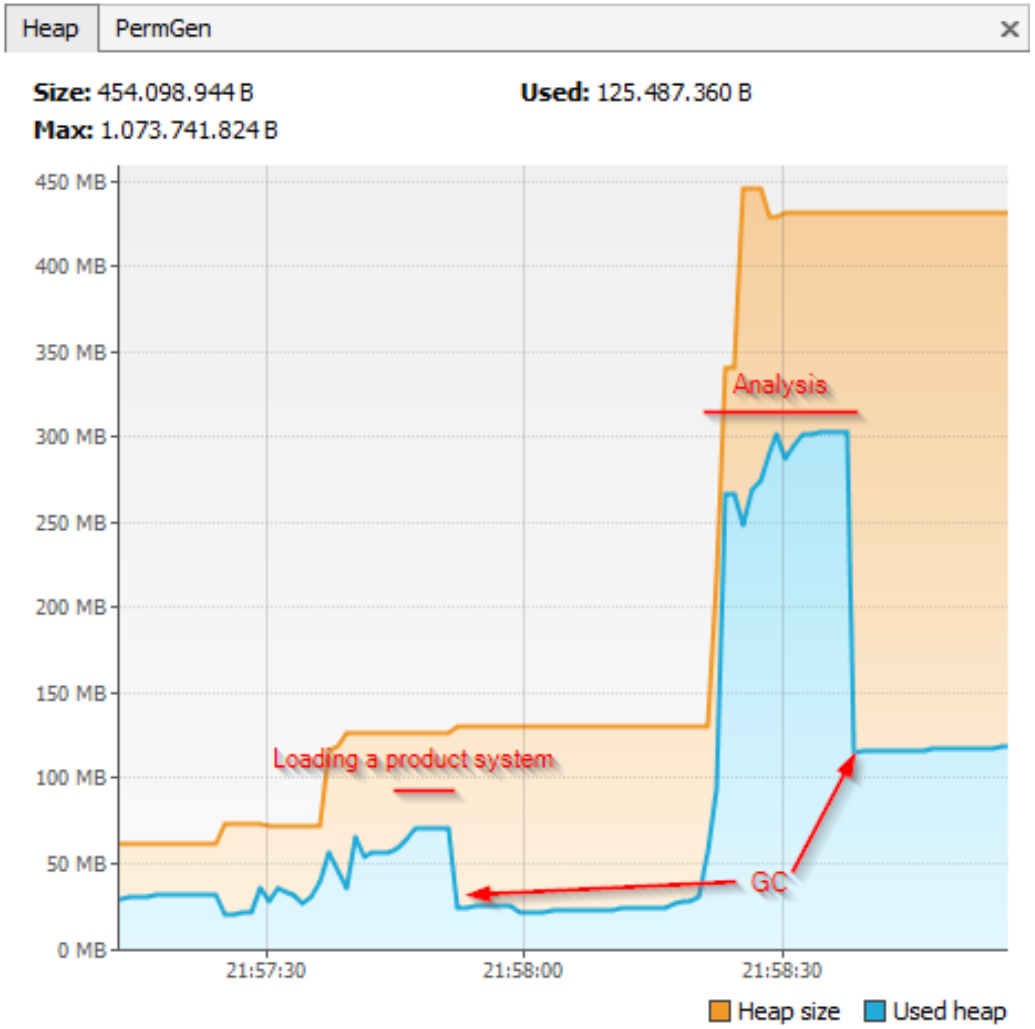
Memory space requirements, example: Loading and analysing a product system, ei2



openLCA 1.4:

Product system open:

25 MB

Analysis peak:

300 MB

Product system & result open:

125 MB

(identical system)

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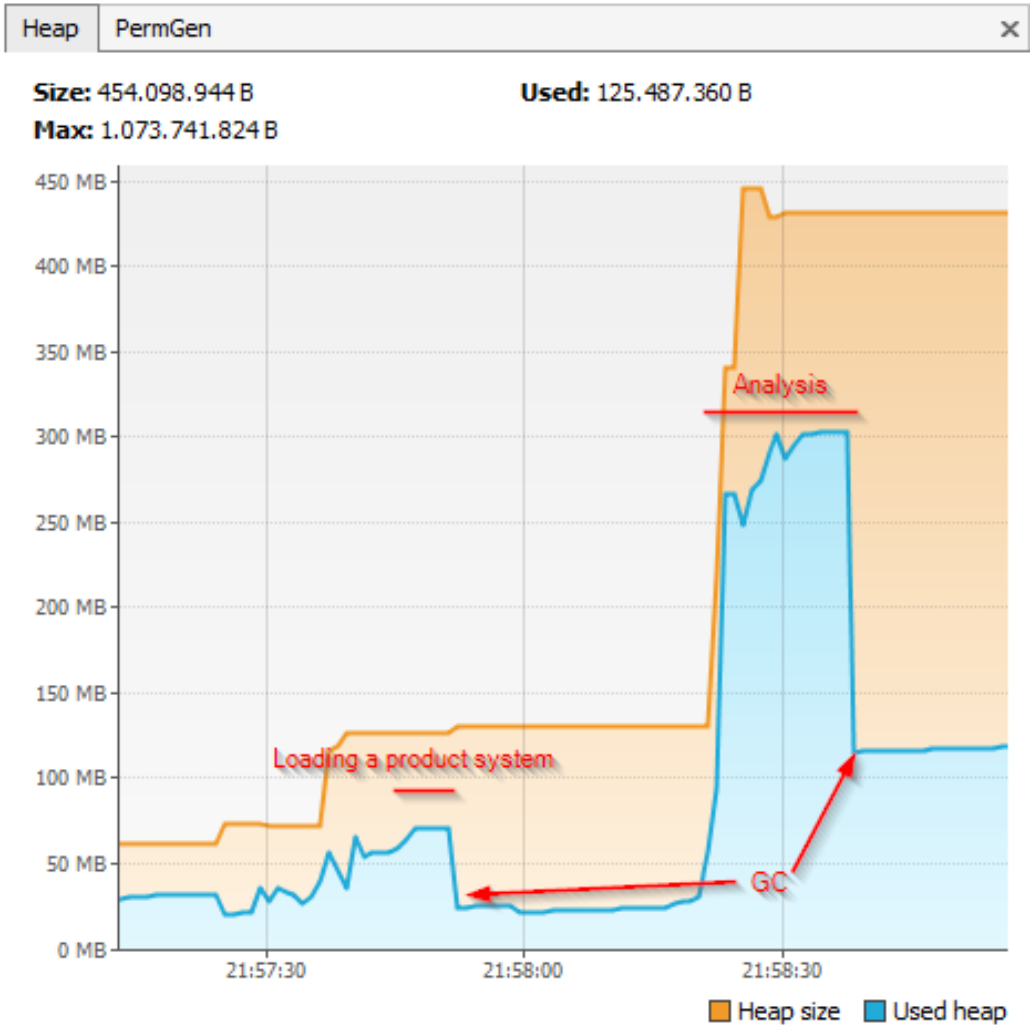
Memory space requirements, example: Loading and analysing a product system, ei2



openLCA 1.4:

Product system open:

25 MB

Analysis peak:

300 MB -33%

Product system & result open:

125 MB -50%

(identical system)

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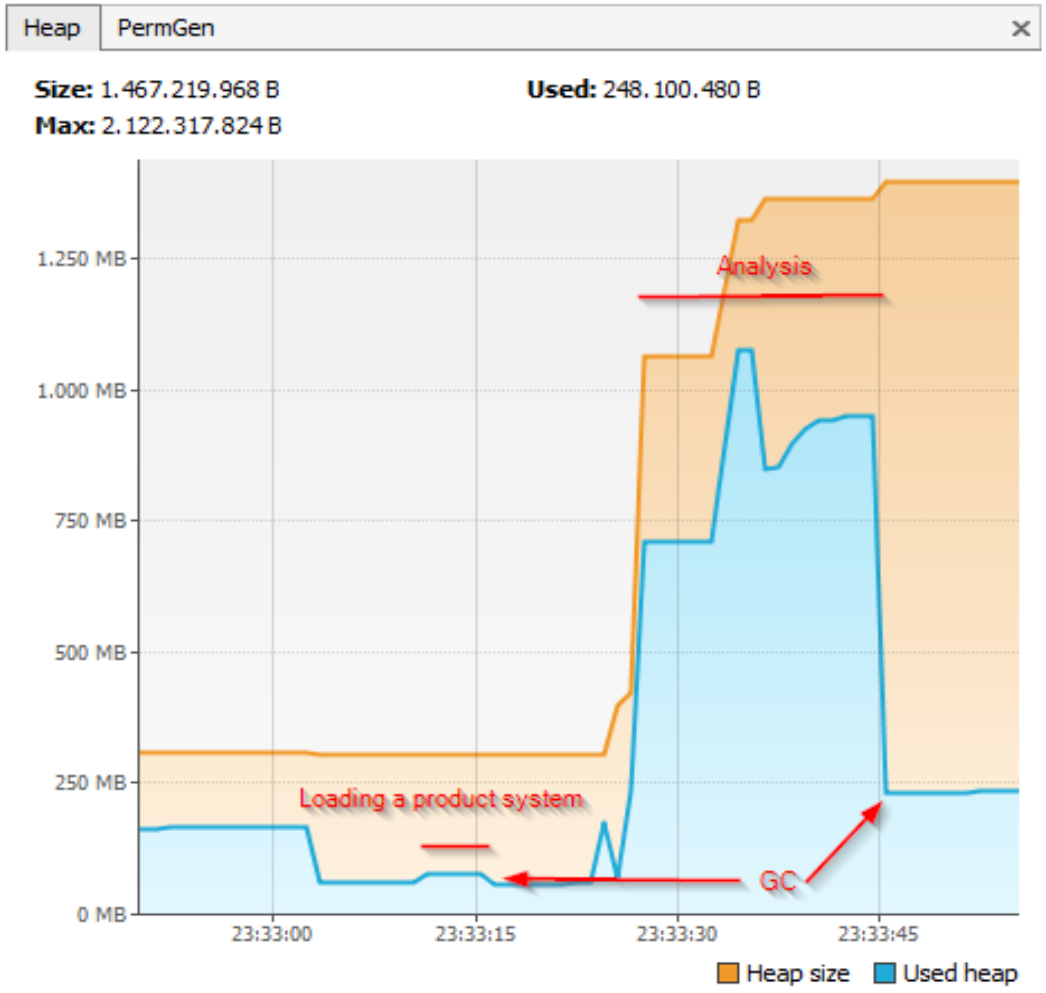
Loading and analysing a product system, Ecoinvent 3



openLCA 1.4:

Product system open:

25 MB

Analysis peak:

1100 MB (!)

Product system & result open:

250 MB

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Performance improvements

Performance improvements due to

- Improved data structures
- Improved queries (batching)
- Improved memory usage (caching)
- Improved algorithms and a faster numerical library

Performance improvements

Ecoinvent 2 example (same computer & product system)

	openLCA 1.3	openLCA 1.4
Creating a new product system	72 sec	3 sec
Opening an existing product system	8 sec	< 1 sec
Calculation and Analysis	10 sec	4 sec

Performance improvements

Ecoinvent 3 example (same computer & product system)

	openLCA 1.4
Creating a new product system	13 sec
Opening an existing product system	< 1 sec
Calculation and Analysis	17 sec

Performance improvements

Ecoinvent 3 example (same computer & product system)

	openLCA 1.4
Creating a new product system	13 sec
Opening an existing product system	< 1 sec
Calculation and Analysis	17 sec

	openLCA 1.3	openLCA 1.4
Creating a new product system	72 sec	3 sec
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Ecoinvent 2 example (same computer & product system)

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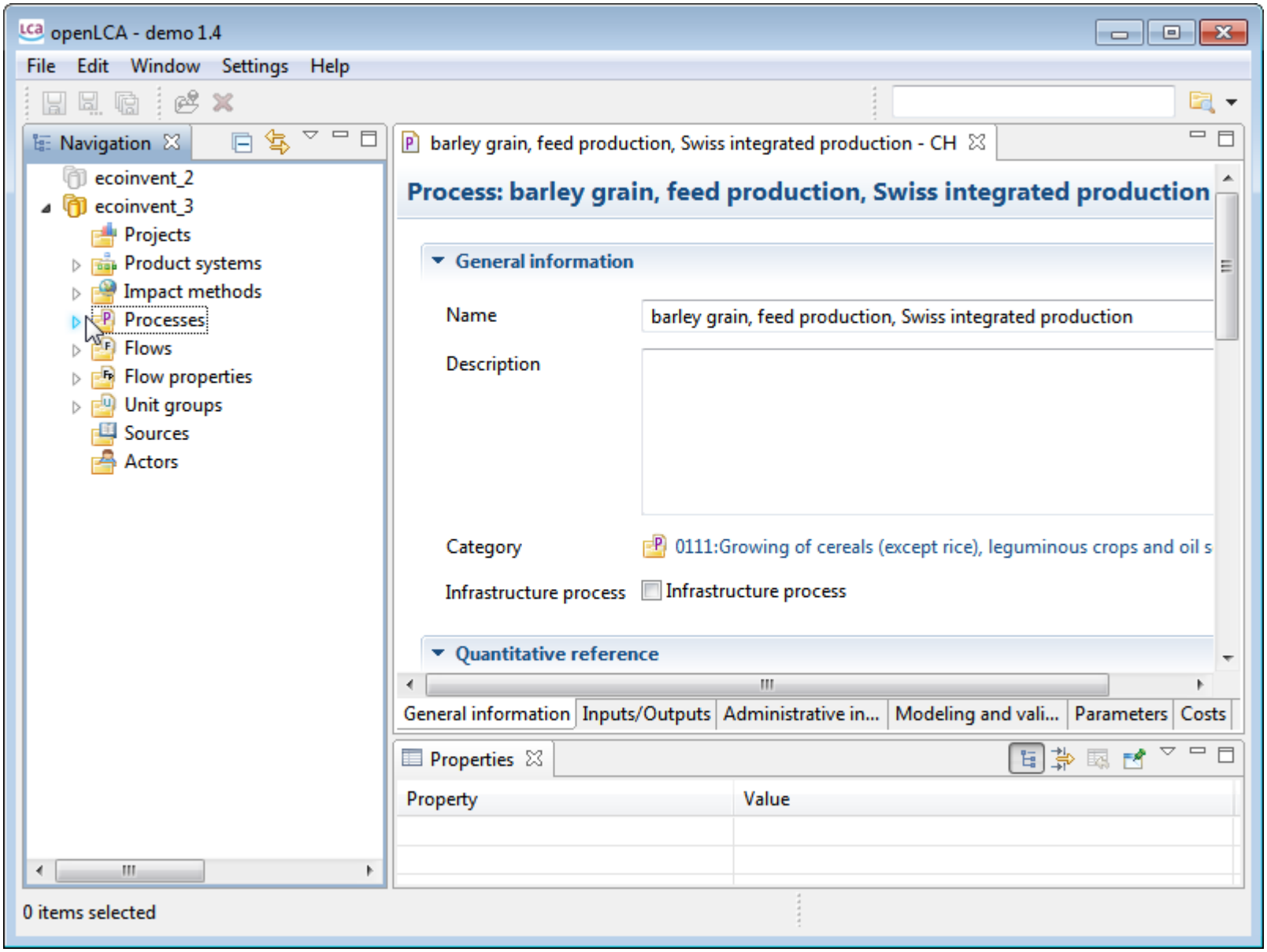
3 ecoinvent 3 in openLCA: Status


openLCA - demo 1.4
File
Edit
Window
Settings
Help
Navigation
ecoinvent_2
ecoinvent_3
Projects
Product systems
Impact methods
Processes
Flows
Flow properties
Unit groups
Sources
Actors
barley grain, feed production, Swiss integrated production - CH
Process: barley grain, feed production, Swiss integrated production
General information
Name
barley grain, feed production, Swiss integrated production
Description
Category
0111:Growing of cereals (except rice), leguminous crops and oil s
Infrastructure process
Infrastructure process
Quantitative reference
General information
Inputs/Outputs
Administrative in...
Modeling and vali...
Parameters
Costs
Properties
Property
Value
0 items selected

3 ecoinvent 3 in openLCA: Status

- A first version 1.4 is available since last week, for use with ecoinvent 3
- This version openLCA 1.4 contains the EcoSpold02 interface and the performance improvements
- It is not publicly released yet
- We are looking for some external testers
- And you can of course schedule a test presentation at our booth or directly with me

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3 ecoinvent 3 in openLCA: Status

www.flickr.com/photos/vestman/

4 Discussion

4 Discussion – one remark only from my side

- The ecoinvent 3 database must be really good to make the implementation effort worthwhile
- Of course performance improvements make sense also for other databases

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Thank you..

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