Welcome to the Life Cycle Assessment (LCA) Learning Module Series

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ACKNOWLEDGEMENTS:

CESTiCC WASHINGTON STATE UNIVERSITY FULBRIGHT

LCA Module Series Groups

Group A: ISO Compliant LCA Overview Modules

Group α: ISO Compliant LCA Detailed Modules

Group B: Environmental Impact Categories Overview Modules

Group β: Environmental Impact Categories Detailed Modules

Group G: General LCA Tools Overview Modules

Group γ: General LCA Tools Detailed Modules

Group T: Transportation-Related LCA Overview Modules

Group τ: Transportation-Related LCA Detailed Modules

General Paid LCA Software Tools

MODULE G1

It is suggested to review Modules A1 and A2 prior to this module

Why Use Software to Handle LCA?

With even moderately large systems, data handling and calculation can be complex and software will help:

- Reduce time needed for assessments
- Prevent errors
- Assisted conversion of data to functional unit basis
- Increase capabilities (e.g. monte carlo simulations, sensitivity analyses)
- Organize systems and data
- Automate creation of graphs and tables
- Provide process and flow information through databases only available in the software package

However, some software/database packages can:

- Be fairly expensive
- Require a learning curve to use effectively

Example of Data Complexity (Output Inventory for Crude Oil from NREL LCI)

Outputs			
2-Hexanone	water/unspecified	ELEMENTARY_FLOW kg	2.32e-08
Acetone	water/unspecified	ELEMENTARY_FLOW kg	3.55e-08
Aluminium	water/unspecified	ELEMENTARY_FLOW kg	3.19e-04
Ammonia	water/unspecified	ELEMENTARY_FLOW kg	5.32e-05
Antimony	water/unspecified	ELEMENTARY_FLOW kg	1.99e-07
Arsenic, ion	water/unspecified	ELEMENTARY_FLOW kg	9.83e-07
BOD5, Biological Oxygen Demand	water/unspecified	ELEMENTARY_FLOW kg	6.19e-04
Barium	water/unspecified	ELEMENTARY_FLOW kg	4.36e-03
Benzene	water/unspecified	ELEMENTARY_FLOW kg	5.96e-06
Benzene, 1-methyl-4-(1-methylethyl)-	water/unspecified	ELEMENTARY_FLOW kg	3.55e-10
Benzene, ethyl-	water/unspecified	ELEMENTARY_FLOW kg	3.35e-07
Benzene, pentamethyl-	water/unspecified	ELEMENTARY_FLOW kg	2.66e-10
Benzenes, alkylated, unspecified	water/unspecified	ELEMENTARY_FLOW kg	1.75e-07
Benzoic acid	water/unspecified	ELEMENTARY_FLOW kg	3.61e-06
Beryllium	water/unspecified	ELEMENTARY_FLOW kg	5.52e-08
Biphenyl	water/unspecified	ELEMENTARY_FLOW kg	1.13e-08
Boron	water/unspecified	ELEMENTARY_FLOW kg	1.12e-05
Bromide	water/unspecified	ELEMENTARY_FLOW kg	7.62e-04
COD, Chemical Oxygen Demand	water/unspecified	ELEMENTARY_FLOW kg	1.02e-03
Cadmium, ion	water/unspecified	ELEMENTARY_FLOW kg	1.45e-07
Calcium, ion	water/unspecified	ELEMENTARY_FLOW kg	1.14e-02
Chloride	water/unspecified	ELEMENTARY_FLOW kg	1.28e-01
Chromium	water/unspecified	ELEMENTARY_FLOW kg	8.50e-06
Cobalt	water/unspecified	ELEMENTARY_FLOW kg	7.88e-08
Copper, ion	water/unspecified	ELEMENTARY_FLOW kg	1.02e-06
Cresol, o-	water/unspecified	ELEMENTARY_FLOW kg	1.02e-07
Cresol, p-	water/unspecified	ELEMENTARY_FLOW kg	1.10e-07
Crude oil, at production	**none**	**PRODUCT_FLOW kg**	**1.00e+00**
Cyanide	water/unspecified	ELEMENTARY_FLOW kg	2.57e-10
Decane	water/unspecified	ELEMENTARY_FLOW kg	1.04e-07
Detergents, oil	water/unspecified	ELEMENTARY_FLOW kg	2.96e-06
Dibenzofuran	water/unspecified	ELEMENTARY_FLOW kg	6.76e-10
Dibenzothiophene	water/unspecified	ELEMENTARY_FLOW kg	3.49e-11
Dibenzothiophene	water/unspecified	ELEMENTARY_FLOW kg	5.48e-10
Dissolved solids	water/unspecified	ELEMENTARY_FLOW kg	1.58e-01
Docosane	water/unspecified	ELEMENTARY_FLOW kg	3.80e-09
Dodecane	water/unspecified	ELEMENTARY_FLOW kg	1.97e-07
Fluorene, 1-methyl-	water/unspecified	ELEMENTARY_FLOW kg	4.05e-10
Fluorenes, alkylated, unspecified	water/unspecified	ELEMENTARY_FLOW kg	1.01e-08
Fluorine	water/unspecified	ELEMENTARY_FLOW kg	4.98e-09
Hexacosane	water/unspecified	ELEMENTARY_FLOW kg	2.37e-09
Hexadecane	water/unspecified	ELEMENTARY_FLOW kg	2.15e-07
Hexanoic acid	water/unspecified	ELEMENTARY_FLOW kg	7.47e-07
Icosane	water/unspecified	ELEMENTARY_FLOW kg	5.41e-08
Iron	water/unspecified	ELEMENTARY_FLOW kg	6.31e-04
Lead	water/unspecified	ELEMENTARY_FLOW kg	2.09e-06
Lead-210/kg	water/unspecified	ELEMENTARY_FLOW kg	3.69e-16
Lithium, ion	water/unspecified	ELEMENTARY_FLOW kg	3.82e-06
Magnesium	water/unspecified	ELEMENTARY_FLOW kg	2.23e-03
Manganese	water/unspecified	ELEMENTARY_FLOW kg	3.56e-06
Mercury	water/unspecified	ELEMENTARY_FLOW kg	3.49e-09
Methane	air/unspecified	ELEMENTARY_FLOW kg	3.53e-03
Methane, monochloro-, R-40	water/unspecified	ELEMENTARY_FLOW kg	1.43e-10
Methyl ethyl ketone	water/unspecified	ELEMENTARY_FLOW kg	2.86e-10
Molybdenum	water/unspecified	ELEMENTARY_FLOW kg	8.17e-08
Naphthalene	water/unspecified	ELEMENTARY_FLOW kg	6.48e-08
Naphthalene, 2-methyl-	water/unspecified	ELEMENTARY_FLOW kg	5.63e-08
Naphthalenes, alkylated, unspecified	water/unspecified	ELEMENTARY_FLOW kg	2.86e-09
Nickel	water/unspecified	ELEMENTARY_FLOW kg	9.77e-07
Octadecane	water/unspecified	ELEMENTARY_FLOW kg	5.30e-08
Oils, unspecified	water/unspecified	ELEMENTARY_FLOW kg	7.20e-05
Pentanone, methyl-	water/unspecified	ELEMENTARY_FLOW kg	1.49e-08
Phenanthrene	water/unspecified	ELEMENTARY_FLOW kg	1.01e-09
Phenanthrenes, alkylated, unspecified	water/unspecified	ELEMENTARY_FLOW kg	1.19e-09
Phenol	water/unspecified	ELEMENTARY_FLOW kg	1.58e-06
Phenol, 2,4-dimethyl-	water/unspecified	ELEMENTARY_FLOW kg	9.96e-08
Radium-226/kg	water/unspecified	ELEMENTARY_FLOW kg	1.28e-13
Radium-228/kg	water/unspecified	ELEMENTARY_FLOW kg	6.57e-16
Selenium	water/unspecified	ELEMENTARY_FLOW kg	3.86e-08
Silver	water/unspecified	ELEMENTARY_FLOW kg	7.47e-06
Sodium, ion	water/unspecified	ELEMENTARY_FLOW kg	3.62e-02
Strontium	water/unspecified	ELEMENTARY_FLOW kg	1.94e-04
Sulfate	water/unspecified	ELEMENTARY_FLOW kg	2.58e-04
Sulfur	water/unspecified	ELEMENTARY_FLOW kg	9.42e-06
Suspended solids, unspecified	water/unspecified	ELEMENTARY_FLOW kg	9.77e-03

Common General LCA Software Tools

General LCA Software Tools

- GaBi
- SimaPro

Most widely used

- Quantis Suite
- Umberto

Generally fully featured with:

- Uncertainty analysis
- Parameterized models
- Graphical model and results capabilities
- More

GaBi

Ganzheitliche **Bi**lanz, German for “holistic balance”

Paid software produced by PE International, free educational version available for students and teachers

GaBi has extensive database options including their own database and integration with external databases, such as ecoinvent, US LCI, etc.

- Most data includes background information, reviews, etc.

Can pay their data team to collect data if needed

Users draw the life cycle “plan” as a flowchart, then calculate impacts

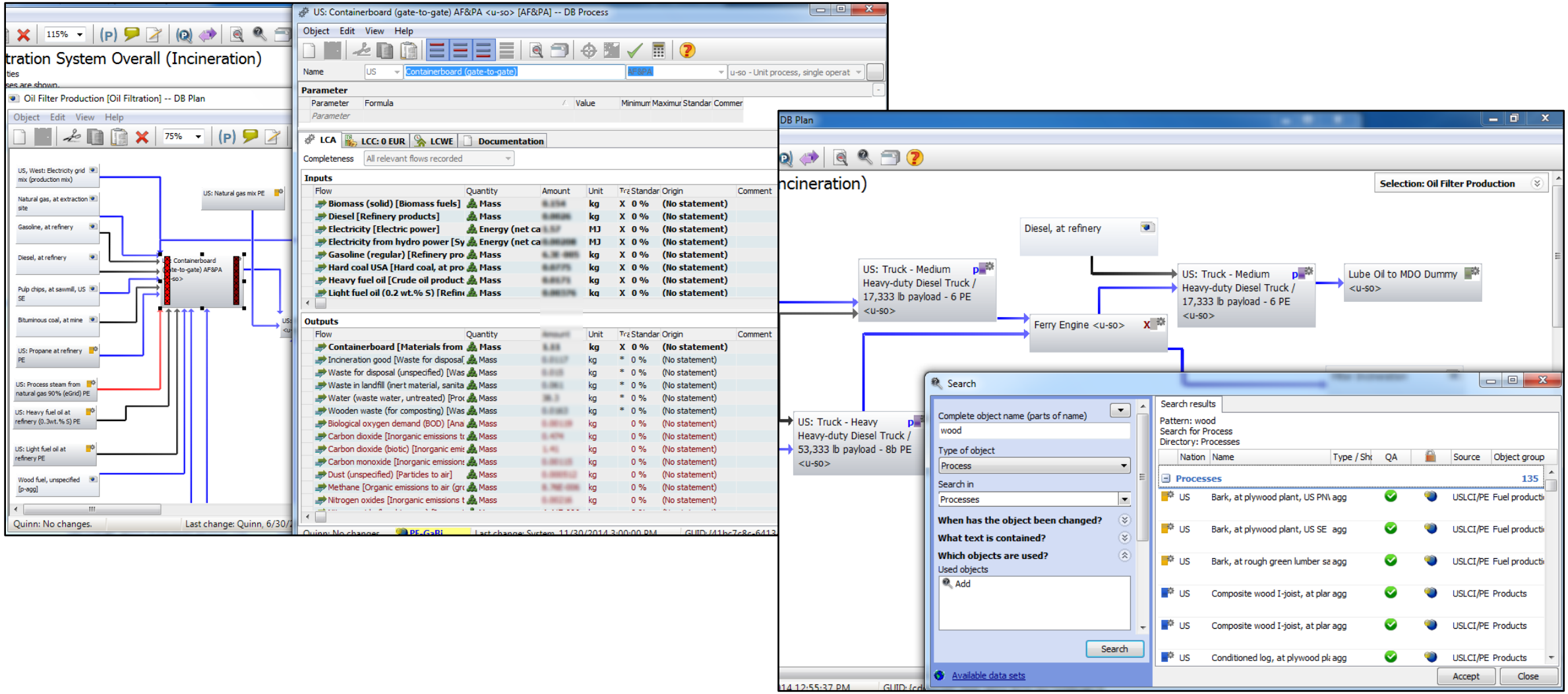
Software calculates results using sequential modeling

Includes i-report feature to produce reports with results

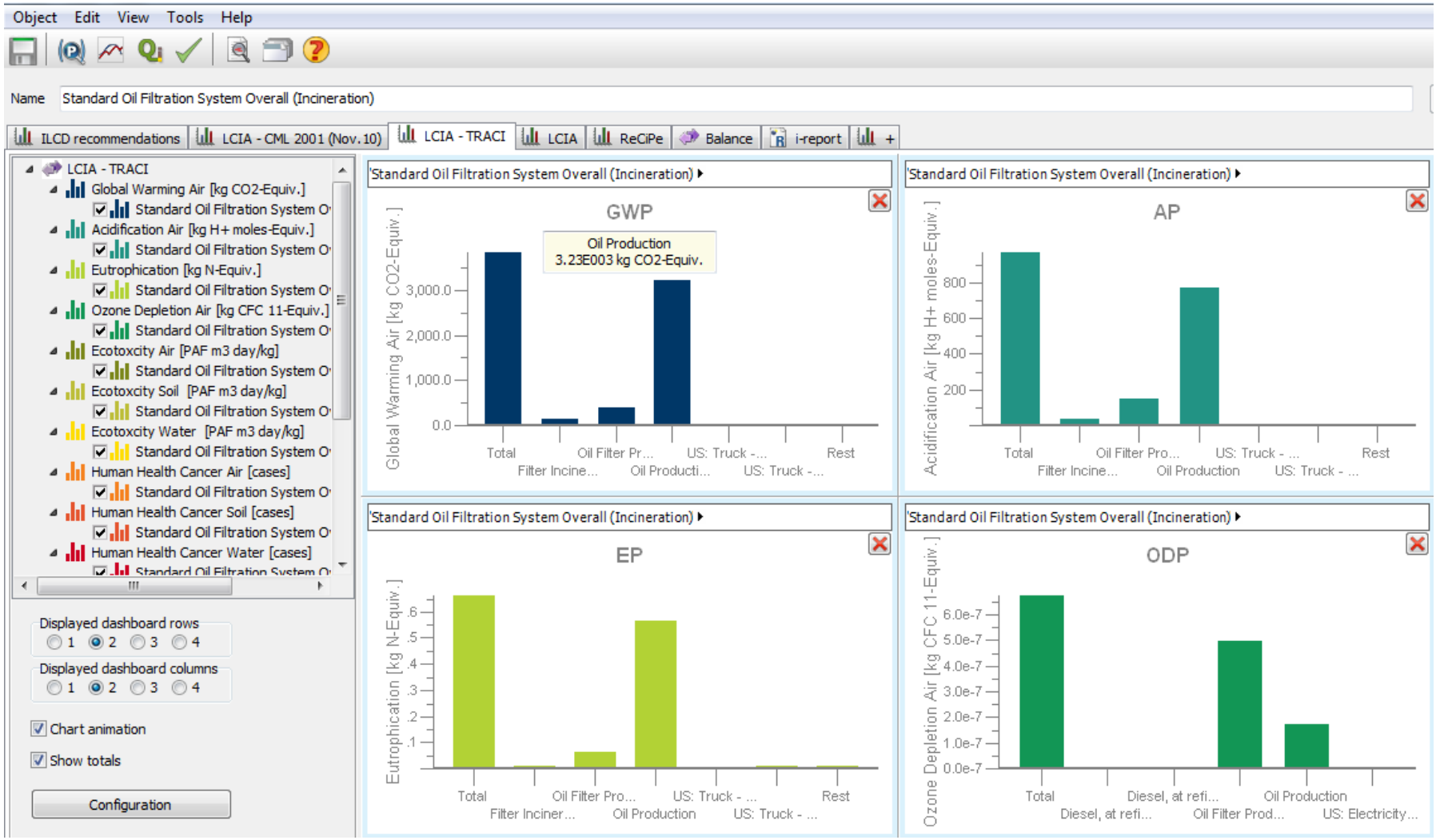
Single computer licenses only (“Buy one, Install one”*)

* http://www.gabi-software.com/america/support/gabi-faq/

GaBi Input


tration System Overall (Incineration)
Oil Filter Production [Oil Filtration] -- DB Plan
US: Containerboard (gate-to-gate) AF&PA <u-so> [AF&PA] -- DB Process
Object Edit View Help
Parameter
Inputs
Outputs
DB Plan
Selection: Oil Filter Production
Diesel, at refinery
US: Truck - Medium Heavy-duty Diesel Truck / 17,333 lb payload - 6 PE <u-so>
Ferry Engine <u-so>
Lube Oil to MDO Dummy <u-so>
US: Truck - Heavy Heavy-duty Diesel Truck / 53,333 lb payload - 8b PE <u-so>
Search
Complete object name (parts of name)
wood
Type of object
Process
Search in
Processes
When has the object been changed?
What text is contained?
Which objects are used?
Used objects
Add
Search
Available data sets
Search results
Pattern: wood
Search for Process
Directory: Processes
Processes 135
Accept
Close

GaBi Output


Object Edit View Tools Help
Name Standard Oil Filtration System Overall (Incineration)
ILCD recommendations
LCIA - CML 2001 (Nov. 10)
LCIA - TRACI
LCIA
ReCiPe
Balance
i-report
LCIA - TRACI
Global Warming Air [kg CO2-Equiv.]
Acidification Air [kg H+ moles-Equiv.]
Eutrophication [kg N-Equiv.]
Ozone Depletion Air [kg CFC 11-Equiv.]
Ecotoxcity Air [PAF m3 day/kg]
Ecotoxcity Soil [PAF m3 day/kg]
Ecotoxcity Water [PAF m3 day/kg]
Human Health Cancer Air [cases]
Human Health Cancer Soil [cases]
Human Health Cancer Water [cases]
Displayed dashboard rows
Displayed dashboard columns
Chart animation
Show totals
Configuration
GWP
Oil Production
3.23E003 kg CO2-Equiv.
Global Warming Air [kg CO2-Equiv.]
AP
Acidification Air [kg H+ moles-Equiv.]
EP
Eutrophication [kg N-Equiv.]
ODP
Ozone Depletion Air [kg CFC 11-Equiv.]

SimaPro

Produced by PRé Consultants

Integrates with US LCI, ELCD, ecoinvent, and LCA food databases

Uses a more text/menu approach to modelling, rather than graphical approach

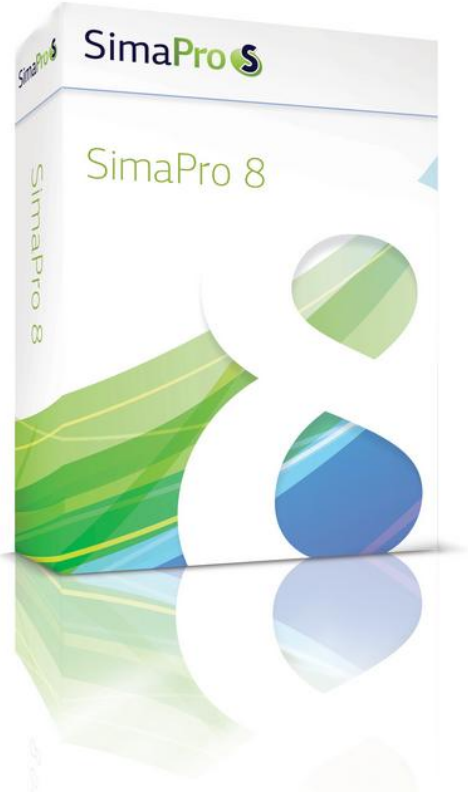
- Though graphical flowcharts can be viewed following data input

Calculates results using matrix inversion

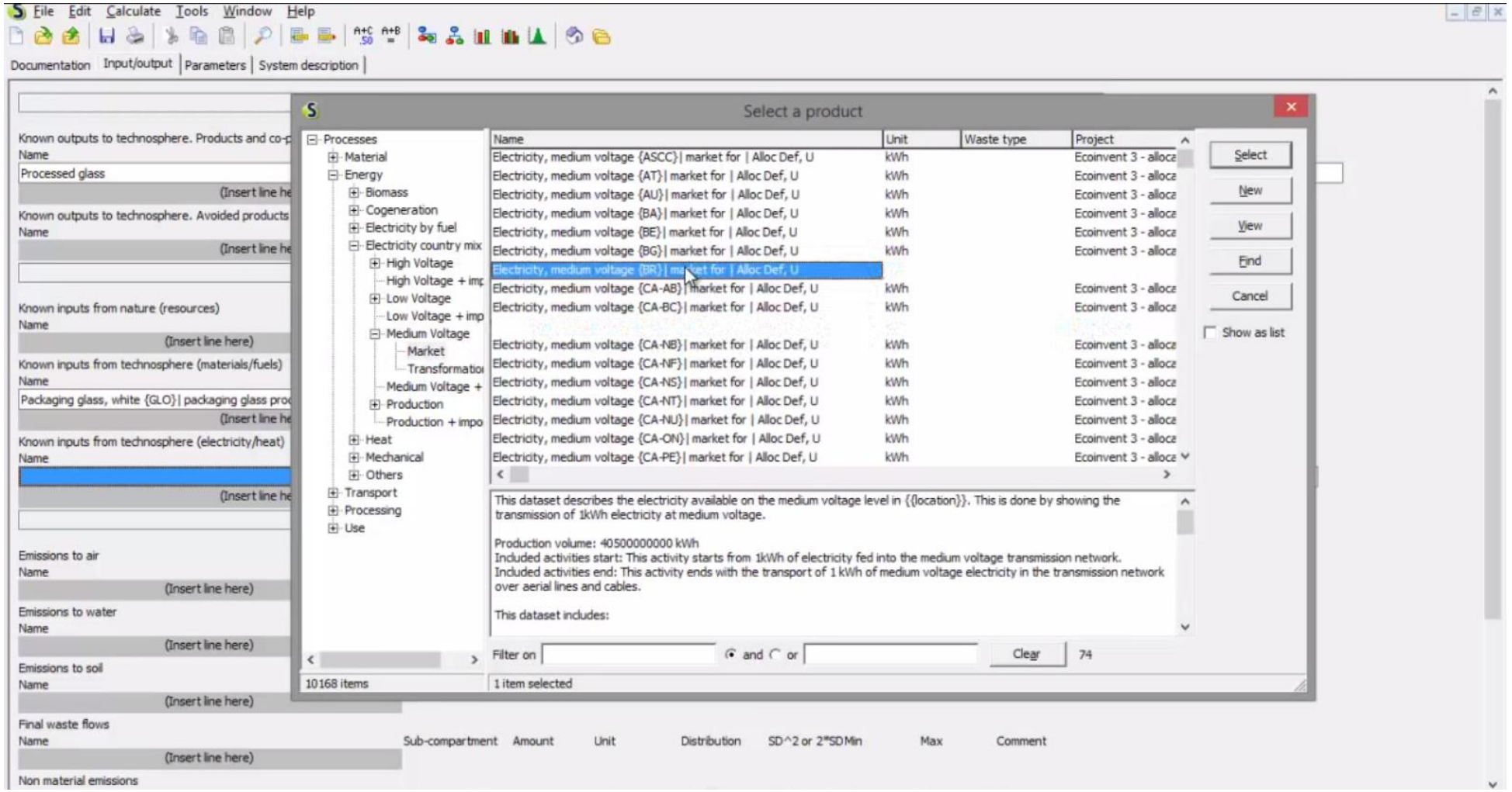
For use by professionals at two levels (Analyst or Developer)

Server based, convenient for multiple users and for remote connection

Appears to be more commonly used, and hence easier to share with others and find tutorial type information

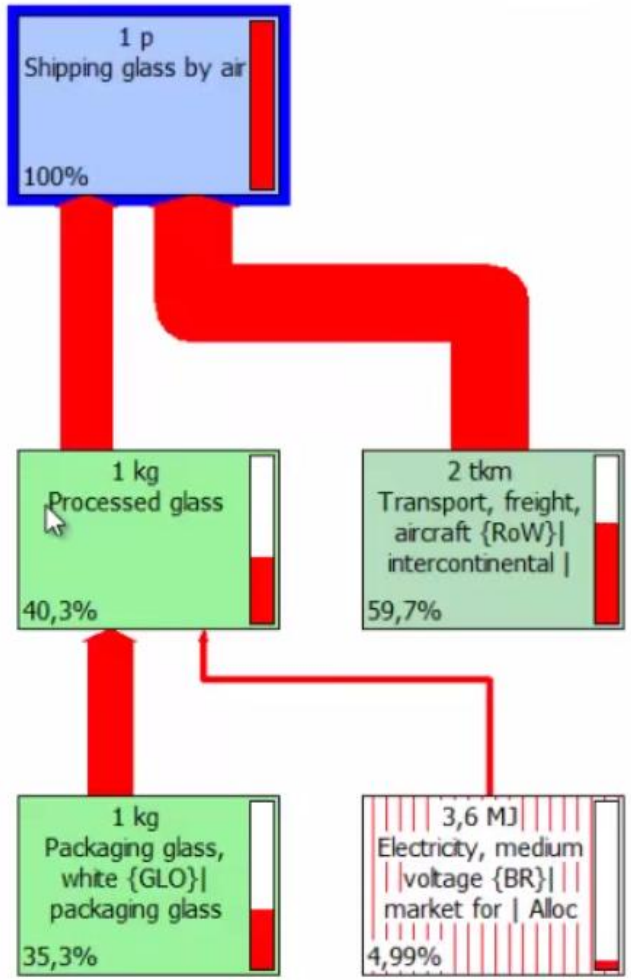


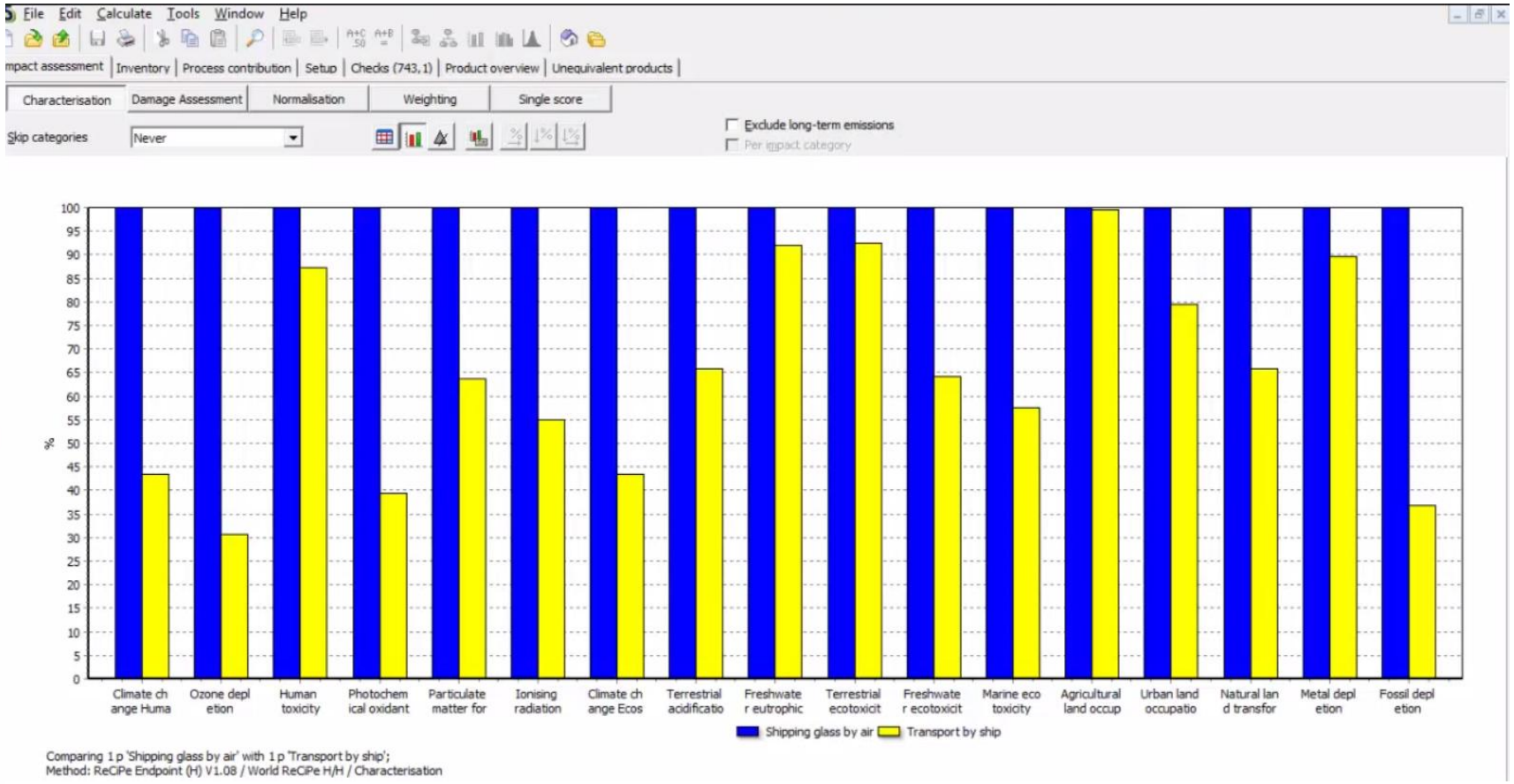
SimaPro Input



Davies, P. (2014). "LCA with SimpaPro8: Tutorial 2" *YouTube*, https://www.youtube.com/watch?v=czqbCs6bwuI

SimaPro Output





Davies, P. (2014). "LCA with SimpaPro8: Tutorial 3" *YouTube*, https://www.youtube.com/watch?v=yFFXumd4M6Y

Smaller Packages within GaBi and SimaPro

SimaPro

- **EarthSmart** is for evaluating the environmental impacts of a Product or Service life cycle
- **e-Dea** is software that allows everyone to design with environmental awareness
- **PackageSmart** is an LCA tool focused on packaging
- **LENS™** is a combined technology, software and expert services solution that allows organisations to manage their utility and environmental compliance costs
- **Superpac** is a Pack design and Pallet loading software.
- **3Pillars** is a Sustainability ROI (Return on Investment) evaluating your triple bottom line

GaBi

- **GaBi Envision** is the dedicated tool to design sustainable products and processes
- **GaBi Server** supports LCA collaboration and is ideal for organisations with two or more LCA practitioners.
- **GaBi DfX** is the professional software for compliance and sustainable product development with a view to the end of life phase

Quantis Suite

Web-based application

Integrates with ecoinvent 2.2 database

Model by phases, drag and drop inputs and processes to the stages. Manually choose quantities.

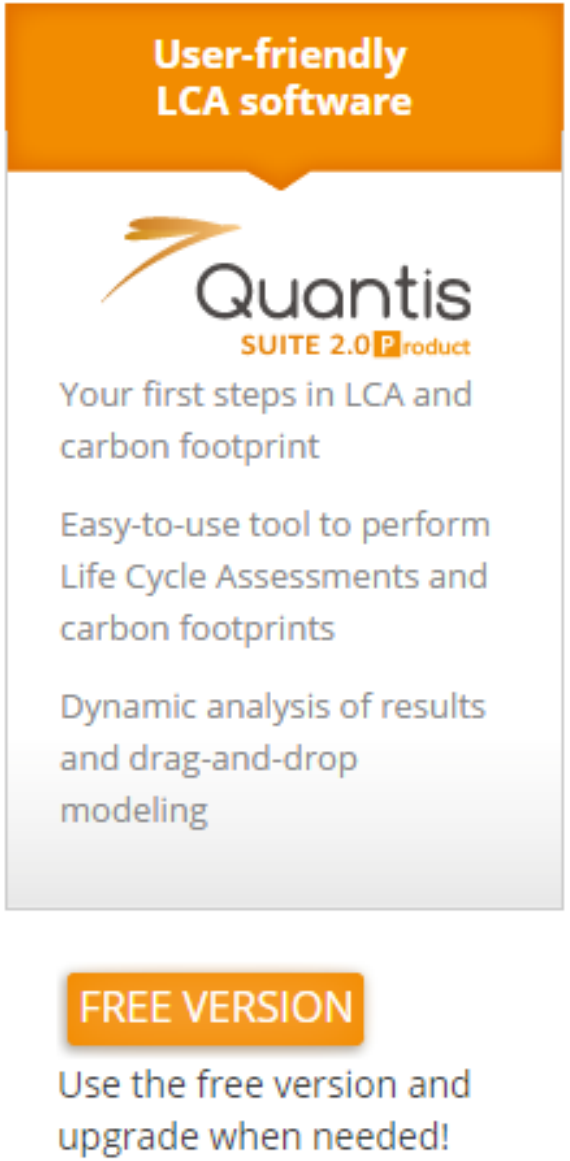
Free trial version available, must purchase full version

- Includes ~400 of the total 4000 processes in ecoinvent
- Includes IMPACT 2002+ impact methodology for five impact categories

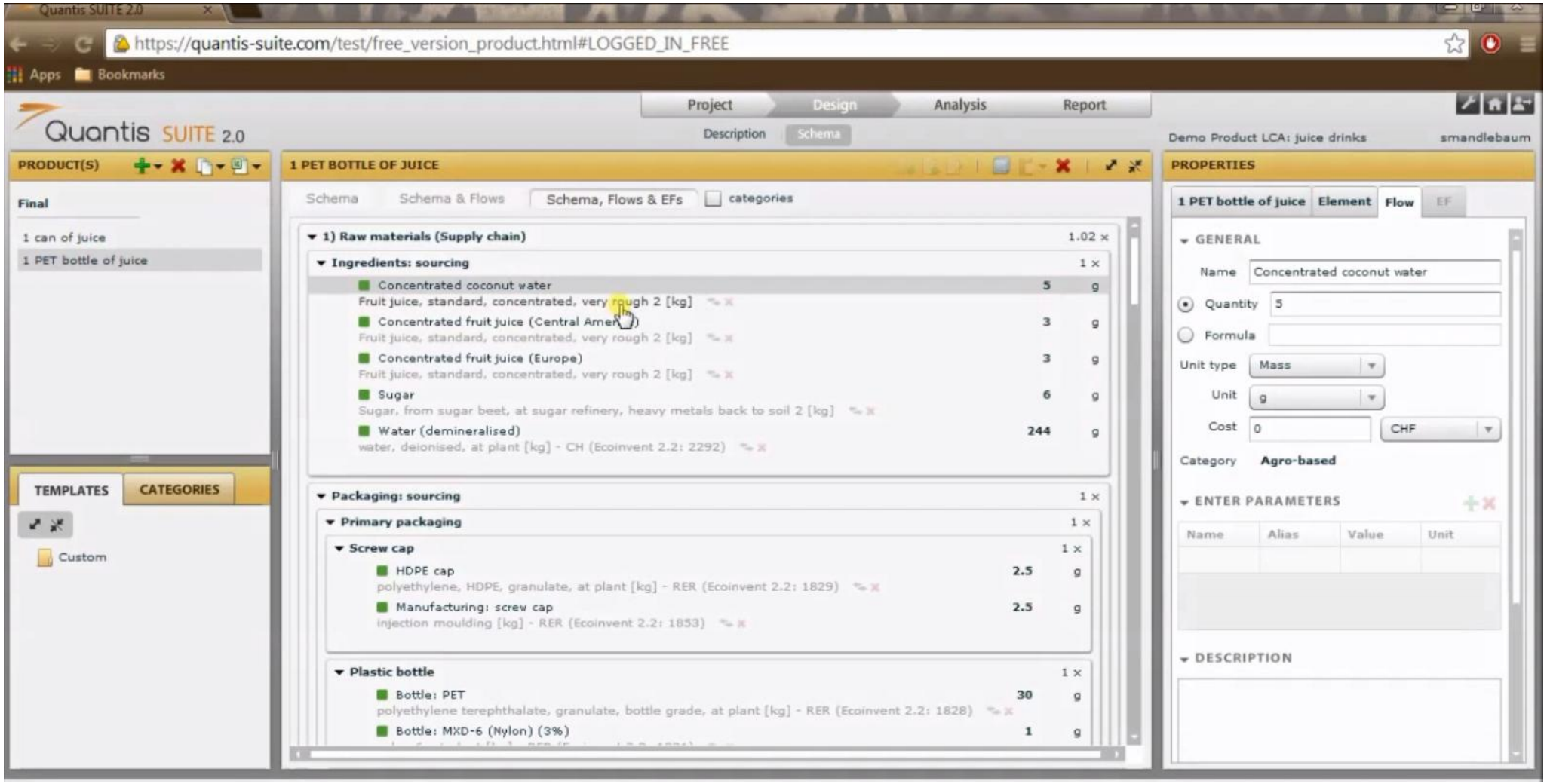
Has partnered with SimaPro on some tools to expand distribution reach and resources

A few versions of the software available

- **Quantis Suite Product – LCAs according to ISO 14040 and carbon footprint**
- Quantis Suite Corporate – Carbon footprint focused, other environmental aspect tools
- Quantis Impulsio – Ecodesign software



Quantis Suite Input



Quantis (2013). "QS Product Free 1 intro tour" *YouTube*, https://www.youtube.com/watch?v=QRHaD91rxwA

Quantis Suite Output

	6) End-of-life	5) Use	4) Distributior	1) Raw materi	2) Delivery an	3) Manufactur	Total	Unit
Human health	-4.776e-8	4.864e-8	6.534e-8	1.672e-7	4.375e-9	1.274e-7	3.652e-7	DALY
Ecosystem qu	-0.0186	0.0194	0.0383	0.0429	1.616e-3	0.0499	0.134	PDF.m2.y
Climate chang	-0.0575	0.0948	0.0951	0.167	4.492e-3	0.224	0.528	kg CO2-eq
Resources [M	-0.75	1.59	1.56	2.63	0.0736	3.86	8.97	MJ
Water withdra	-1.116e-3	9.781e-4	7.233e-4	3.793e-3	3.935e-5	6.815e-3	0.0112	m3

Quantis (2013). "QS Product Free 1 intro tour" *YouTube*, https://www.youtube.com/watch?v=QRHaD91rxwA

Umberto

Produced by ifu Hamburg

Integrate with ecoinvent 3 (included with software) and GaBi (separate purchase) databases

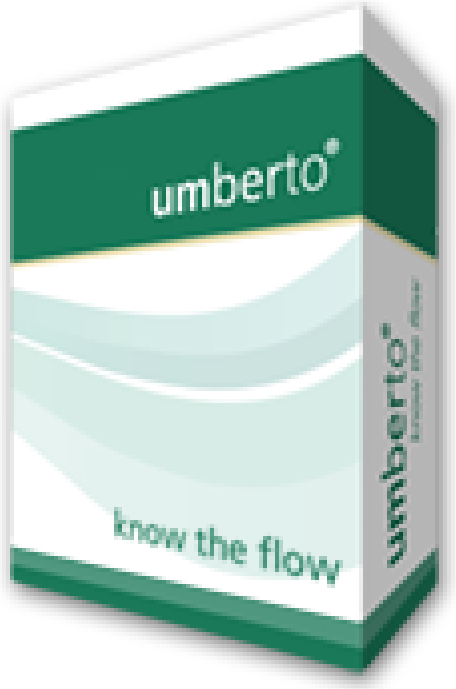
Frequent online web demos

Graphically oriented modelling approach featuring Sankey diagrams

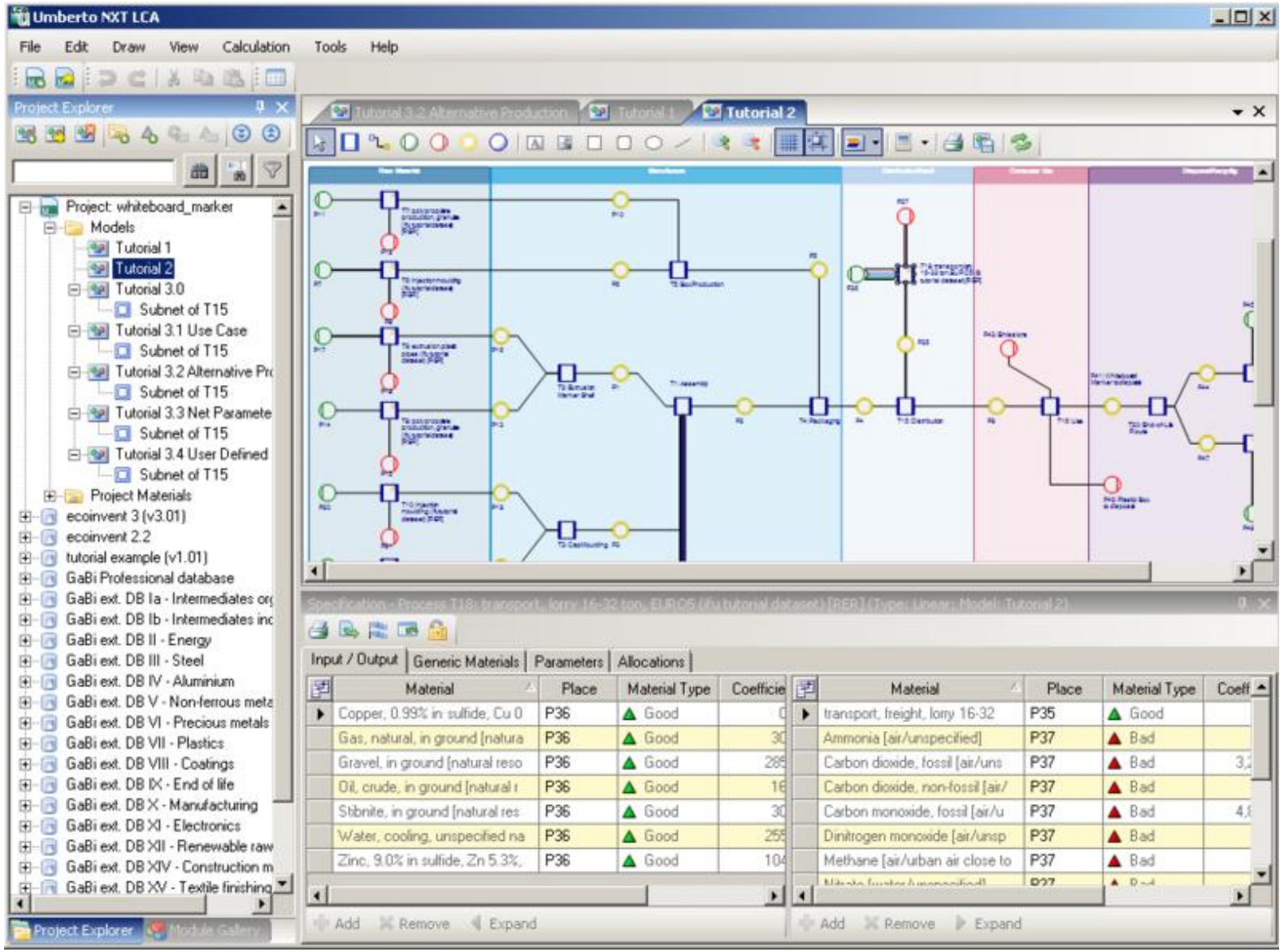
Interfaces with Microsoft Excel and other Office programs

Multiple versions depending on needs

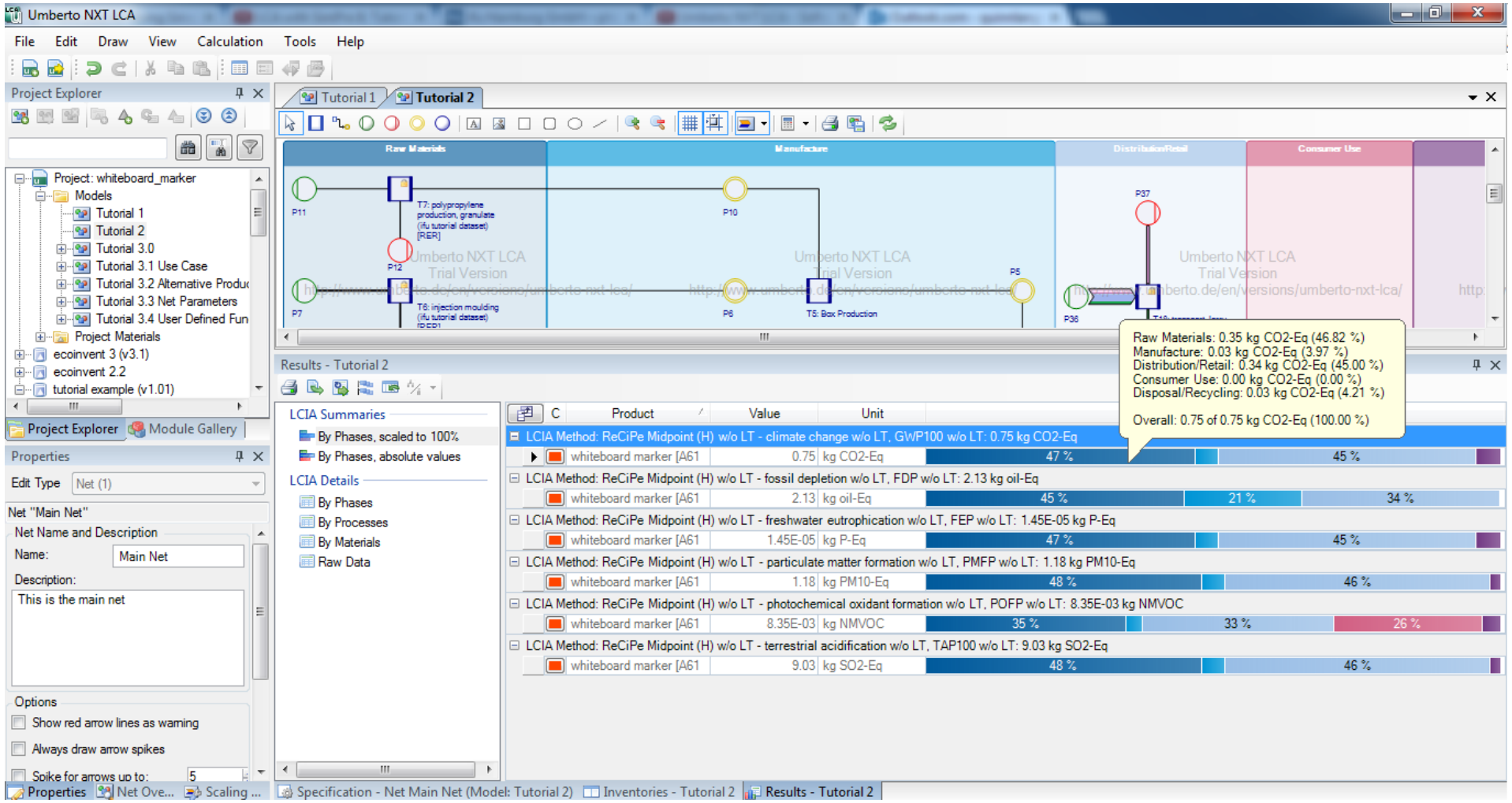
- NXT Efficiency: Costs, materials, and energy
- NXT LCA: Life cycle assessment
- NXT CO_2: Carbon footprint only
- NXT Universal: Combines environmental with cost and efficiency



Umberto Input



Umberto Output



Conclusion

Free Trial Links GaBi SimaPro Quantis Umberto

Most of these software options have similar features

Most have the ability to use data from multiple databases including ecoinvent and GaBi databases

Main differences seem to be in the user interfaces

- Free trial versions are available for each to get a feel for their input and output style

There are a few differences in specific extra features such as ability to generate reports within the software, be used remotely, export to other programs, and have add-ons for specific goals

Cost of each software may vary and most require requesting a quote to see pricing structure

Bottom Line:

Each one accomplishes the main functionality of simplifying the process of a life cycle assessment, but may differ slightly in specialized capabilities and style of use

Thank you for completing Module G1!

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Self-Assessment Quiz

MODULE G1: General Paid LCA Tools

Which of these can be an advantage of using software to handle an LCA over doing one by hand?

- [ ] Prevent computational errors
- [ ] Increase capabilities
- [ ] Reduce time needed to carry out the assessment
- [ ] All of the above

Correct!

There are many advantages of using software to help compute LCA results, though those covered here must be purchased and may require a learning curve.

Which software tool produces and features their own database for their tool?

- GaBi
- SimaPro
- Quantis Suite
- Umberto

Correct!

PE international produces its own databases for GaBi while the other tools tend to rely more on third-party data sources. All of the softwares can use data from other sources like ecoinvent and the US LCI.

Which software tool operates exclusively as an online platform?

- GaBi
- SimaPro
- Quantis Suite
- Umberto

Correct!

Quantis Suite is the only tool covered that operates as a web-based tool. The other software options have various ways to connect over the internet, but are based on a computer or server.

Is there only one version of each software or multiple options to choose from?

- Only one version of each
- Multiple options

Correct!

Each tool has either different versions or add-on packages for specific tasks and goals, depending on the needs of the assessment (e.g. CO_2 only, costs in addition to LCA, etc.)

Which software tool offers a free trial version?

- GaBi
- SimaPro
- Quantis Suite
- Umberto
- All of the above

Correct!

All of these offer free trial versions so you can explore the interface and features of each tool for yourself. Links to the free trial pages are on the conclusion slide (slide 20).