

“Fast Track” LCA¹ for Dummies

Additional information for the Optimisatieproject of the course IO2070 Technische Productoptimalisatie, 2010-2011.

By Joost Vogtländer and Merel Segers

Introduction

There are many “magic mystery” stories about LCA: difficult, complex, not accurate, takes many months, only for environmental zealots, etc. This guide, however, shows the way you can quickly make LCAs in practice. It can take you less than a day. Forget theoretical deliberations and complications for a moment. Just do it².

LCA in practice is quite similar to a cost comparison of two or more products (or services):

- An LCA of one product does not make sense: it should always be a comparison of two or more products (or a redesign of a product, where you compare the old with the new design)
- The simplest situation is that the compared products have exactly the same functionality and quality. In practice, however, different design solutions differ in terms of quality (in the broad sense of the word). Then you must give your own interpretation of the results (you might be helped here by the EVR), see

http://www.ecocostsvalue.com/httpdocs/content/html/startpagina/startpag_4.html.

Note that this complication is not specific to LCA, since you would have a similar situation in a cost comparison.

- Be aware that the accuracy of an LCA is not high: differences less than 30% are in most cases not relevant.

Note that this is similar to calculations on costs: data from general databases are often not more accurate than 25%.

- There are several types of LCA:

“from cradle to gate” (i.e. from the mines to the gate at a warehouse) and

“from gate to gate” (to calculate the eco-burden of a manufacturing facility)

“from gate to grave” (to calculate End of Life scenarios)

“from cradle to grave” (to calculate the total eco-burden of a product system from mine to End of Life) and

“from cradle to cradle” (closing the loop in the total product system)

Note that this is similar to “Product Costs” and “Production costs” respectively “Whole Life Costs” (or “Life Cycle Costs”)

¹ “Fast Track” refers to an LCA which is made by means of look-up tables (e.g. in Excel) or computer software with standard databases. This in contrast with the “Rigorous” LCA as described in the formal Handbooks of LCA (see

http://www.ecocostsvalue.com/httpdocs/content/html/startpagina/startpag_8.html)

² For students who are interested in the background of LCA and/or interested in the background of the so-called “single indicators”, see the videos on 2 LCA lectures at www.ecocostsvalue.com (homepage, click on videos in the left column).

Choice of “single indicator”

When you make a cost calculation, you must choose the currency (€, \$, £, etc.). When you make an LCA you must select the “single indicator”.

At Delft University of Technology you have to choose between 3 indicators:

- a “damage based” indicator: the recipe indicator (=the new ecoindicator '99) H/A (unit= Points)
- a single issue indicator: “global warming” only, the carbon footprint (unit= kg CO2 equivalent)
- a “prevention based” indicator: the eco-costs 2007 (unit= €)

Three remarks:

- The carbon footprint is not suitable for cradle-to-cradle (recycling) analysis, since materials depletion is not incorporated in the indicator.
- The recipe indicator gives unsatisfactory results for combustion at the end of life in the Ecoinvent database. The results in the Idemat database are OK.
- For wood, End of Life and C2C calculations, the eco-costs give the most satisfactory results

There are two databases: Ecoinvent and Idemat. Ecoinvent contains over 4500 LCIs. Idemat³ has over 900 LCIs. It is strongly advised to look first in the Idemat list. When something is not available there, look in Ecoinvent.

You will experience that the actual calculation is a matter of minutes, so you might consider to make your LCA in all the 3 single indicators, and find out whether or not your conclusion is influenced by the choice of the indicator system.

The 3 indicators are totally different in character. Therefore it is not possible to conclude that one system is better than the other (it is a matter of taste).

For the LCA's you make in the 'IO2070 Technische product optimalisatie' course, you will use Excel and you will base your analyses on the eco-costs 2007.

Methods for making LCAs

1) Spreadsheets in Excel

It is advised to do everything in excel, just as you do when you make a cost comparison.

You start your LCA with a table (see the simple example on the next page):

- step 1 make a list of important elements (materials, electricity, transport, waste treatment, etc)
- **step 2 add the single indicator factor (from excel look-up tables or LCA software)**
- **step 3 multiply and add up to the total score**

For step 2 you will need the excel table on the ecocostsvalue.com website, also available on the blackboard:

[Ecocosts 2007 LCA data on products and services V2-2, 2010](#)

³ The Idemat LCIs are based the Ecoinvent LCIs. The reasons to make this extra set of LCIs were:

- extra LCIs on alloys (frequently used by designers and engineers)
- a correction on the “market mix” data of metals (Ecoinvent data are outdated)
- extra LCI on wood types (softwood types as well as hardwood types)
- a specific selection of LCIs for electricity, heat and transport
- extra LCIs on End of Life (combustion, waste incineration, recycling)
- the Danish food LCIs based on Ecoinvent (instead of ETH data)
- eliminate double counting (of CO2 and fossil fuels) of electricity in eco-costs

When your problem is simple, look first at the tab “summary general industry” and “summary building industry”. For product design, look first at “full list Idemat”. When you still cannot find your product or process, look at “full lists ecoinvent”.

Data on volume based transport (e.g. for transport of boxes with domestic appliances) are not given in the standard databases but can be found in tab “summary general industry” (see also www.ecocostsvalue.com tab FAQs). **Distances for sea born freight can be find at www.searates.com/reference/portdistance** . Distances over land: see Google Maps

Notes:

- the excel tables have more information than EcoScan
- it easier to find a product or process in the excel tables than to find it in Simapro
- the advantage of the excel tables is that you can work at home

Example summary table:

step 1				step 2		step 3	
				factor		score	
materials	steel	0,8	kg	0,49	€/kg	0,392	€
	polypropylene	0,3	kg	1,02	€/kg	0,306	€
production	electroplating chrome	0,2	m2	2,28	€/m2	0,456	€
transport	sea container	21	tonkm	0,0052	€/tonkm	0,109	€
use	electricity	3,6	kWh	0,109	€/kWh	0,392	€
end of life	land fill	1,1	kg	0,118	€/kg	0,13	€
	Total					1,785	€

For the LCA's you make in the 'IO2070 Technische product optimalisatie' course, you must use the format of the Excel sheet as given on the last page of this document (this excel file is available on the blackboard)

2) EcoScan (not for TPO students, since the database does not contain all required data)

Ecoscan is the most user friendly program to do LCA's with and has a database which is sufficient for most simple cases.

It is available at the computers at IO TUDelft.

To analyze a product in EcoScan you use a Product Life Cycle form (PLC form). By filling in the production, usage and disposal sheets, you specify the product. In this way you analyze the main stages of a product life cycle. The filling out of these sheets is merely a question of dragging and dropping data from ready-made databases into the form. Do not use the automatic disposal mode in EcoScan but make your own choices in the End of Life stage.

The big disadvantages of EcoScan are that it has a limited database and that the input and output cannot be exported in Excel. So the results can only be reported “as it is” and analyses are limited.

3) Cambridge Engineering Selector (CES)

The Cambridge Engineering Selector is a software package for selection of materials and production processes. The power of CES is its materials selection at the beginning of the design process. The developers of CES adopted eco-costs as the best available single indicator, so a new database “Level 2 with eco-data” with eco-costs is available. However, the CES EcoAudit tool (=LCA tool) has still to be adapted (it has some flaws, and is therefore not allowed for TPO students).

Note:

To speed-up the selection of materials, a book with LCA data is available:

A quick reference guide to LCA data and eco-based materials selection, Joost G. Vogtlander, VSSD, Delft, 2011.

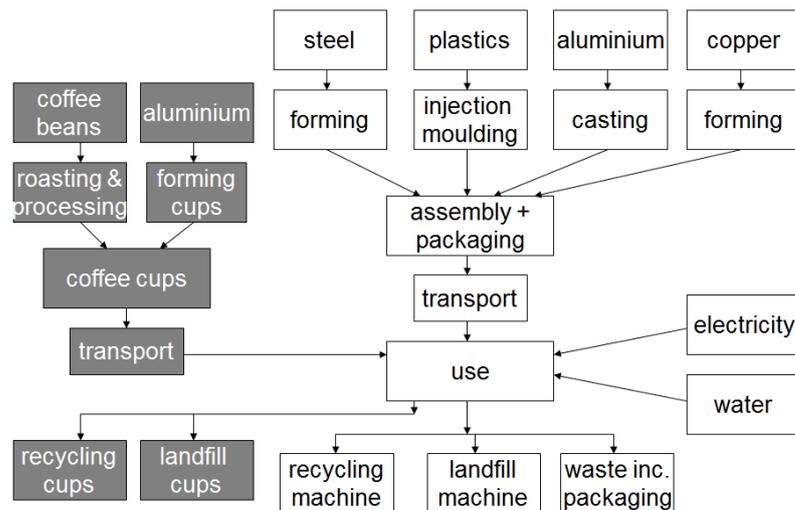
A Step by Step procedure.

Step 1 Establish the scope and the goal of your analysis

- o Is it a comparison of two products?
- o Is it an attempt to improve the environmental characteristics of a typical design?
 - less, or less harmful, materials?
 - less energy in the use phase?
 - less transport?
 - better recycling or better incineration of waste for electricity?
 - Cradle to Cradle solution?
 - better durability?

Step 2 Establishment of "Functional Unit" and System Boundaries

- o describe the function (system requirements) of your product or service
 - Example for a coffee machine: 1000 cups of coffee per year (or: cups over the life time)
 - Example for a transport system: 50 m3 freight over a distance of 300 km, no payload back
- o make a drawing of your product system (from cradle to grave or). See the example below for a coffee machine
- o determine the life time of the system components
- o establish one or more transport scenarios (e.g. production in China or in Eastern Europe)
- o establish the system boundaries (what do you include and what do you neglect in your system?)



A "process tree" in LCA of a coffee machine

Step 3 Quantify materials, use of energy, etc. in your system

- o collect (measure) data (e.g. weight, material, energy consumption)
- o determine accuracy and relevance; establish scenarios and cut-off criteria (e.g. neglect parts which are very small)

Step 4 Enter the data into an Excel calculation sheet

If an indicator value for a material or process is missing this causes a missing indicator/material problem that can be resolved as follows:

- check whether the missing indicator could make a significant contribution to the total environmental impact.
- substitute a known process for the unknown one which has the same characteristics (take a “surrogate” process)
For example: If you miss an indicator value for a certain type of plastic, find out which known plastic is similar.
- request an environmental expert to calculate the indicator value. Software packages are available for this purpose.
- take the required energy for the process, calculate the eco-costs of it, and add the eco-costs of the extreme toxic emissions (if any).
It is generally better to estimate than to omit.

Step 5 Interpret the results and draw your conclusions

In this step you determine what can be improved (less pollution materials and processes). You make a comparison between alternatives.

- When you have entered everything in your computer program or calculation sheet, you can add up the total eco-costs of your product (and/or service). However, it is not the aim of an LCA to have the total eco-costs only. The aim of LCA is always a comparison with other products and/or alternative designs or processes. So, the last step of LCA is an analysis of the total output, including relevant details.
- Note: it might be that you conclude in this last step that you have to (partly) redo your calculation, since elements are missing or are not accurate enough.

Further readings:

A practical guide to LCA, for students, designers and business managers; Cradle-to-Grave and Cradle-to-Cradle, Joost G. Vogtländer, VSSD, Delft, 2010.

An example of the LCA calculation of a coffee machine in Excel:

list of materials		eco-costs data		result	total
PRODUCTION	weight (kg)	process step	eco-costs (€)	eco-costs (€)	eco-costs (€)
PS=polystyrene	y1	production	1.338	=C5*F5	polystyrene =G5+G6
	y1	moulding	0.257	=C6*F6	
aluminium	y2	production	2.748	=C8*F8	aluminium =G8+G9
	y2	extrusion	0.307	=C9*F9	
sheet steel	y3	production	0.494	=C11*F11	steel =G11+G12
	y3	forming	0.086	=C12*F12	
glas	y4	production	0.300	=C14*F14	glass =G14+G15
	y4	forming	0.222	=C15*F15	
plus other small components, such as the heating coil (copper from Idemat), electrical cable (Idemat), and packaging (board from Idemat)					
TRANSPORT					
from-to	m3	km			
Shanghai-R'dam	z1	x1	0.0044	=C20*D20*F20	transport =G20
plus other transport legs					
USE PHASE					
type	weight (kg)	energy (kWh)			
electricity	-	e1	0.030	=D24*F24	electricity materials use phase =G24 =G25
plus materials which are used in the use phase (in this case cofee, packaging, water)					
END of LIFE					
type	weight (kg)	process step			
PS	y1	municipal waste	0.273	=C28*F28	EoL PS =G28
aluminium	part of y2	landfill	0.118	=C30*F30	
aluminium	part of y2	to recycling	0.049	=C31*F31	EoL aluminium =G30+G31
sheet steel	part of y3	landfill	0.118	=C33*F33	
sheet steel	part of y3	to recycling	0.010	=C34*F34	EoL steel =G33+G34
glas	y4	landfill	0.118	=C36*F36	
plus the materials of the use phase					
				Total eco-costs (€)	=SUM(H7:H37)

use this gray area to make a bar chart or pie chart

text for graphic charts