«Introduzione alla metodologia LCA (*Life Cycle Assessment*)» "

«*Attrezzi*» per la LCA

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Organizzazione dell'intervento

- **A Review of LCA Methods and Tools and their Suitability for SMEs**

- OpenLCA 1.4 case study of a beer bottle: Aluminium can vs PET bottle

- **Discussione**

- **A Review of LCA Methods and Tools and their Suitability for SMEs**

Hannele Lehtinen, Anna Saarentaus, Juulia Rouhiainen, Michael Pitts and Adisa Azapagic

https://www.researchgate.net/profile/Dr_Kumar79/post/How_to_measure_LCA_results_in_a_single_index/attachment/59d622c6c49f478072e99067/AS%3A272119152218113%401441889669850/download/120321+BIOCHEM+LCA_review.pdf

Oltre ai documenti ISO14040 e 14044, un riferimento rilevante per QA e consistenza degli studi di LCA

The International Reference Life Cycle Data System (ILCD) Handbook (EU, 2012)

http://eplca.jrc.ec.europa.eu/uploads/JRC-Reference-Report-ILCD-Handbook-Towards-more-sustainable-production-and-consumption-for-a-resource-efficient-Europe.pdf

Life cycle thinking

Successful and sustainable innovation depends on having a clear understanding of the impacts and benefits of a product or service throughout the whole life cycle from the sourcing of raw materials to ultimate disposal at end of life

Five key stages in the life cycle of a product or service:

Raw materials – sourcing the materials required for the product or service

Production – converting raw materials and assembling the products

Distribution – getting the product to the end user

Use – where the end user derives the direct value from the product or service

End of life – what happens when the end user has finished with the product or service

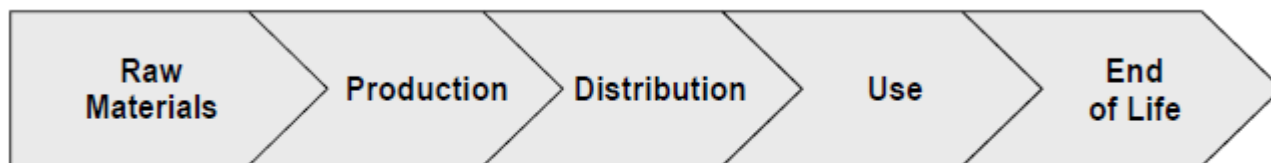**Figure 1 Stages in the life cycle of a product**

Dati per I e O
(Misure caso-specifiche,
Database,
Bibliografia).

Effetti su risorse,
ambiente,
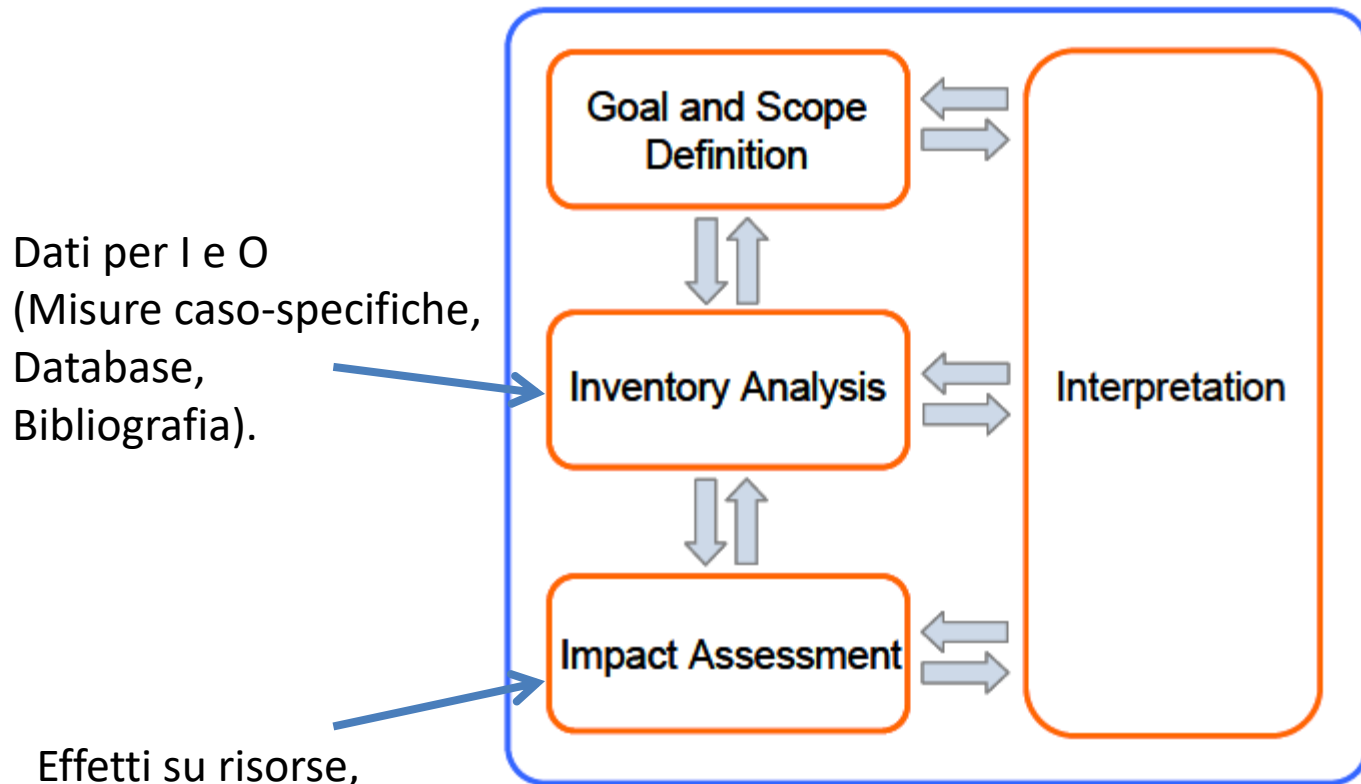salute
(Classificazione e
Caratterizzazione)

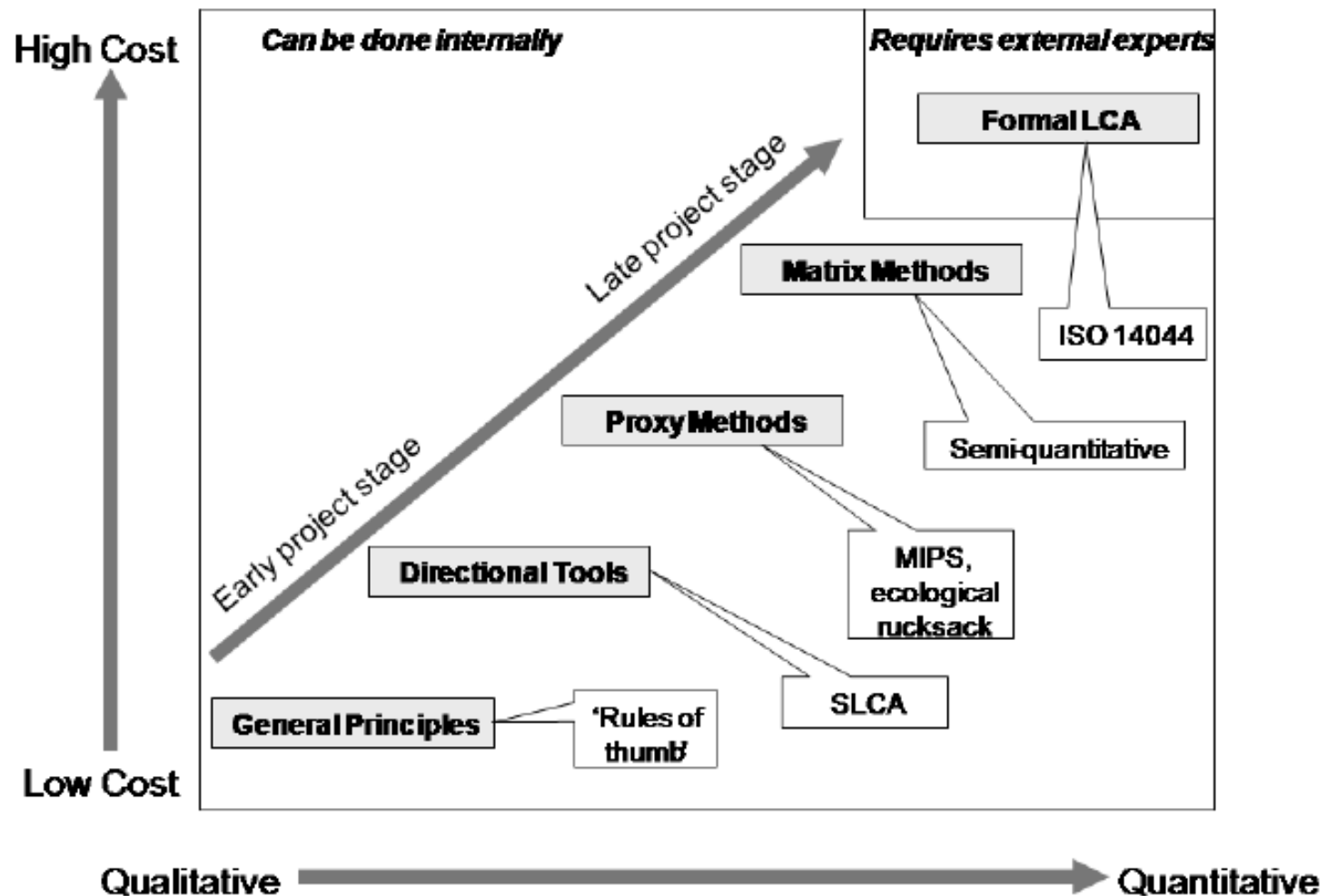Figure 5 The methodological framework for LCA (ISO, 2006a)

Figure 6 *Different LCA tools and methodologies, depending on the intended application*
(CIKTN, 2009; also based on discussions with Chris Sherwin, Forum for the Future)

- **Matrix-based LCA**
- A more streamlined (ndP: snello) approach to LCA scores each stage of the life cycle for impact on a number of environmental indicators. Typical indicators include resource depletion, global warming potential, smog production, acidification, eutrophication, toxic waste production and biodiversity impact. Impact is estimated using a simple numerical scale. The completed matrix is used to focus attention on areas for improvement.

Proxy measures

Streamlined LCA methods are still too complicated for many applications. So proxy measures have been developed that _use a **single value** to represent the environmental impact of a product or material_. Examples include:

- **Embodied energy** - this is a commonly available indicator and works well for systems that are dominated by energy use, such as packaging and construction. "L'emergia può essere definita come l'energia solare totale equivalente che viene usata sia direttamente sia indirettamente per produrre beni o servizi." (H.T.Odum, 1996, H.T. & E.C.Odum, 2000) ...**Transformity**: _emergia in ingresso per unità di energia disponibile in uscita_. Ad esempio, se occorrono 10000 emjoule solari per produrre un joule di energia dal legname, la transformity del legno è 10000 seJ/J. La transformity solare associata alla radiazione del Sole assorbita dalla Terra è per definizione pari a 1.

- **Material input per unit of service (MIPS)** - overcomes some of the issues of embodied energy by accounting for all material movements, but does not really discriminate between materials with different environmental risks. Ecological rucksack is a simple version of this that describes the _amount of material moved from nature_.

- **Ecological footprint** - measures the _total land area that is required to support the production of the service, product or lifestyle_. Most commonly used to communicate the impact of different life styles on the total amount of land required to support each society.

- **Eco-indicators** - an attempt to model a wide _range of impacts that are then weighted against each other and summed into a single value_. Because of the value judgments built into weighting the different impact categories, these are subjective measures of actual impact. An example method is the _Eco-indicator 99 model_, which has been used by designers and several LCA software packages support it (e.g. SimaPro and Gabi).

Directional tools

Very simple assessments can be used to identify areas of focus in innovation and to suggest directions to explore. It is a simple matrix of the stages of a product life cycle and four "system conditions" defined by the Natural Step as being critical to sustainability. Each cell in the matrix is filled in using a series of questions designed to be answered with a simple yes or no, and scored on a scale from good to bad. A quick SLCA can be carried out in a group discussion based on already available information.

	RAW MATERIALS	PRODUCTION	PACKAGING AND DISTRIBUTION	USE AND PERIPHERALS	END-OF-LFE
SC1: Scarce materials taken from the earth					
SC2: Man-made persistent materials					
SC3: Degradation of nature					
SC4: Meeting people's needs					

Key

Good	Quite Good	OK	Quite Bad	Bad	Don't Know
All answers positive. System condition met.	Mostly positive responses. System condition mostly met.	Some positive responses. System condition on the way to being met.	Mostly negative responses. System condition mostly not met.	All answers negative. System condition not met.	Insufficient knowledge to make reasonable judgment.

https://thenaturalstep.org/wp-content/uploads/2018/01/SLCA-matrix-structure.pdf

STREAMLINED LCA / ANALISI DI CICLO DI VITA «SNELLA» O RAZIONALIZZATA

http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=ACADEMY_StreamlinedLCA.pdf

General principles

General principles, common sense and rules of thumb can all be used to make a swift assessment of the life cycle impacts. For example, for most product and services energy costs dominate the overall environmental impacts. Thus, lower impacts can be obtained by:

- using low embodied energy materials;
- efficient manufacturing processes;
- reducing distribution costs;
- low energy use per functional unit (unit of service); and
- no complex clean up at end-of-life.

«Attrezzi» per la valutazione del ciclo di vita (LCA)

Tool name	Supplier	Supports LCI and/or LCIA*	Supports full LCA*	Language	Main database	Special area if any	Free?	If commercial, availability of free trials	Web page
AIST-LCA Ver.4	National Institute of Advanced Industrial Science and Technology (AIST)		Yes	Japanese	AIST-LCA database		No	No free trial available	http://www.aist-riss.jp/main/modules/product/software/nire.html?ml_lang=en
BEES 4.0	National Institute of Standards and Technology (NIST)		Yes	English	Bees database	Construction industry	Yes		http://www.nist.gov/el/economics/BEESSoftware.cfm
CCaLC Tool	The University of Manchester		Yes	English	CCaLC database including EcoInvent database		Yes		http://www.ccalc.org.uk/index.php
Eco-Bat 2.1	Haute Ecole d'Ingénierie et de Gestion du Canton de Vaud	Yes		French, Italian, English	Eco-Bat database	Construction industry	No		http://www.eco-bat.ch/index.php?option=com_content&view=frontpage&Itemid=1&lang=en
Ecoinvent waste disposal inventory tools v1.0	Doka Life Cycle Assessments (Doka Okobilanzen)	Yes		English	Ecoinvent database	Waste management	No	Yes	http://www.ecoinvent.ch/
EIME V3.0	CODDE		Yes	English	EIME database	Electrical, mechanical and electronic products	No	Yes	http://www.codde.fr/page.php?rubrique=20
Environmental Impact Estimator V3.0.2	Athena Sustainable Materials Institute		Yes	English	Own database	Construction industry	No	Yes	http://www.athenasmi.org/
eVerdEE v.2.0	ENEA - Italian National Agency for New Technology, Energy and the Environment		Yes	Italian, English	ENEA database		Yes		http://www.ecosmes.net/cm/index-EP
GaBi 4	PE International GmbH University of Stuttgart, LBP-GaBi		Yes	English	Gabi database		No	Yes	http://www.gabi-software.com/index.php?id=85&L=0&redirect=1
GEMIS version 4.4	Oeko-Institut (Institute for applied Ecology),	Yes		Spanish, Czech,		Energy, transport,	No		http://www.gemis.de/

Name	Developer			Language	Database	Application			URL
	Darmstadt Office			German, English		recycling and waste treatment			
KCL-ECO 4.1	VTT		Yes	English			No		http://www.vtt.fi/research/technology/sustainability_assessment.jsp?lang=en
LEGEP 1.2	LEGEP Software GmbH		Yes	English, German	LEGEP database	Construction industry	No	Yes	http://www.legep.de/index.php?AktivId=1125
LTE OGIP; Version 5.0; Build-Number 2092; 2005/12/12	t.h.e. Software GmbH		Yes	German		Construction industry	No		http://www.the-software.de/ogip/einfuehrung.html
OpenLCA	GreenDeltaTC GmbH		Yes	English			Yes		http://www.openlca.org
Qantis suite 2.0	Quantis		Yes	English	Qantis database		No	Yes	http://www.quantis-intl.com/software.php?step=fonct
REGIS 2.3	sinum AG		Yes	Japanese, Spanish, German, English	ecoinvent Data v1.3:		No	Yes	http://www.sinum.com/en/products/software/
SALCA-tools	Agroscope Reckenholz-Tänikon Research Station ART	Yes		German		Agriculture		Free for tool developers, project partners. Access can be negotiated case by case with the developers	http://www.agroscope.admin.ch/aktuell/index.html?lang=en
SankeyEditor 3.0	STENUM GmbH	Yes		English			No	Yes	http://www.stenum.at/en/?id=software/sankey/sankey-intro
SimaPro 7	PRé Consultants B.V.		Yes	E.g. Spanish, French, Italian, German, English	SimaPro database		No	Yes	http://www.pre.nl/
TEAM™ 4.5	Ecobilan - PricewaterhouseCoopers		Yes	English			(Yes)	Some versions free, others have demo available	https://www.ecobilan.com/uk_team.php
The Boustead Model 5.0.12	Boustead Consulting Limited		Yes	English	The Boustead Model database		No	Yes	http://www.boustead-consulting.co.uk/
Umberto 5.5	ifu Hamburg GmbH		Yes	English	Umberto library		No	Yes	http://www.umberto.de/en/product/index.htm
USES-LCA	Radboud University Nijmegen	Yes		English		Toxic impacts between substances	Yes		http://www.ru.nl/environmentalscience/research/life_cycle/multimedia_toxic/
WRATE	UK Environment Agency		Yes	English		Municipal waste management systems	No	Yes	http://lca.jrc.ec.europa.eu/lcainfohub/tool2.vm?tid=197

Table 2 Free LCA databases

Database name	Supplier	Languages	Special area, if any	Website
CCaLC database	The University of Manchester	English		www.ccalc.org.uk
CPM LCA Database	Centre for Environmental Assessment of Product and Material Systems - CPM	English		http://cpmdatabase.cpm.chalmers.se/
Eurofer data sets	EUROFER	English	Steel industry	www.eurofer.org
GEMIS 4.4	Oeko-Institut (Institute for applied Ecology), Darmstadt Office	Spanish Czech German English	Energy, transport, recycling and waste treatment	http://www.gemis.de/
Franklin Associates' Case examples	Franklin Associates	English		http://www.fal.com/projects.html
ILCD	European Commission	English		http://lca.jrc.ec.europa.eu/lcainfohub/datasetArea.vm
LC Data	Forschungszentrum Karlsruhe	German English	Energy, transport and end of life	www.lci-network.de
LCA_sostenipra_v.1.0	Universitat Autònoma de Barcelona (UAB)	Spanish Catalan English	biomass production (energy crops and forest biomass), wood use and recycling (energy and products), ecodesign, sustainable architecture, service systems and green chemistry	http://www.sostenipra.cat/
MFA_sostenipra_v.1.0	Universitat Autònoma de Barcelona (UAB)	Spanish Catalan English		http://www.sostenipra.cat/
PlasticsEurope Eco-profiles	PlasticsEurope	English	Polymers (main) and their intermediates	http://www.plasticseurope.org/plastics-sustainability/life-cycle-thinking.aspx
ProBas	Umweltbundesamt	German		http://www.probas.umweltbundesamt.de/php/index.php
US Life Cycle Inventory Database	Athena Sustainable Materials Institute	English		http://www.nrel.gov/lci/database/default.asp

Database commerciali

Database name	Supplier	Free demo/trial available	Languages	Special area, if any	Website
DEAM™	Ecobilan - PricewaterhouseCoopers	No	English		https://www.ecobilan.com/uk_deam.php
EcoInvent Data v1.3	EcoInvent Centre	Yes	Japanese English		http://www.ecoinvent.org/
EIME V11.0	CODDE	Yes	Spanish French English	Selection of products	http://www.codde.fr/page.php?rubrique=20
esu-services database v1	ESU-services Ltd.	No	German English		http://www.esu-services.ch/index.php?id=104
GaBi databases 2006	PE International GmbH	No	Japanese German English		http://www.gabi-software.com/international/software/gabi-4/
Option data pack	National Institute of Advanced Industrial Science and Technology (AIST)	No	Japanese	Chemical production, iron & steel and waste management processes	http://www.jemai.or.jp/english/index.cfm
Sabento library 1.1	ifu Hamburg GmbH	No	German English	Enzymatic processes, cell cultures, and microbiological systems	http://www.sabento.com/en/demo/index.htm
SALCA 071	Agroscope Reckenholz-Tänikon Research Station ART	No (free to developers)	German English	Agriculture	http://www.agroscope.admin.ch/oekobilanzen/01198/index.html?lang=en
SimaPro database	PRé Consultants B.V.	Yes	English		http://www.pre.nl/simapro/inventory_databases.htm
sirAdos 1.2.	LEGEP Software GmbH	No	German	Construction	http://lca.jrc.ec.europa.eu/lcainfohub/database2.vm?dbid=128
The Boustead Model 5.0.12	Boustead Consulting Limited	No	English	Fuels, materials	http://www.boustead-consulting.co.uk/
Umberto library 5.5	ifu Hamburg GmbH	Yes	German English		http://www.umberto.de/en/product/index.htm

(Suitability of tools and databases for biochemical industry)

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News

Apr 14 2016: Webinar "Introducing PSILCA 1.0" now available on YouTube!

Mar 03 2016: NEW RELEASE: openLCA 1.5.0 beta 1 available!

openLCA is a free, professional Life Cycle Assessment (LCA) and footprint software with a broad range of features and many available databases, created by GreenDelta since 2006. It is an open source software; the software and its source code is freely available. The software is fully transparent and can be modified by anyone.

Besides being open source and free, openLCA offers...

http://www.openlca.org/case_studies

OpenLCA 1.4 case study of a beer bottle: Aluminium can vs PET bottle

functional unit can be defined as 500ml beer container (PET bottle, ALU can)

system boundary of this assessment includes production, consumption and disposal of the bottle within the US

exemplary character, showing the functions and capabilities of the software and sharing a typical case of eco-design

2 Goal , Scope and limitation of this Assessment
2.1 Goal definition
The goal of this case study is to compare environmental impact between two different materials of a typical 500ml beer bottle packaging in the US. The packaging can be made of aluminum or of PET (Polyethylene Terephthalate).