Life cycle assessment

http://lcinitiative.unep.fr/

http://lca.jrc.ec.europa.eu/lcainfohub/index.vm

http://www.lbpgabi.uni-stuttgart.de/english/referenzen_e.html

"Cradle-to-grave" redirects here. For other uses, see Cradle to the Grave (disambiguation).

Recycling concepts

- Dematerialization
- Zero waste
- Waste hierarchy
  - Reduce
  - Reuse
  - Recycle
- Regiving
- Freeganism
- Dumpster diving
- Industrial ecology
- Simple living
- Barter
- Ecodesign
- Ethical consumerism

Recyclable materials

- Plastic recycling
- Aluminium recycling
- Battery recycling
- Glass recycling
- Paper recycling
- Textile recycling
- Timber recycling
- Scrap
- e-waste
- Food waste

This box: view • talk • edit

A **life cycle assessment** (**LCA**, also known as **life cycle analysis**, **ecobalance**, and **cradle-to-grave analysis**) is the investigation and valuation of the environmental impacts of a given product or service caused or necessitated by its existence.

Contents

[hide]

[edit] Goals and Purpose of LCA

The goal of LCA is to compare the full range of environmental and social damages assignable to products and services, to be able to choose the least burdensome one. At present it is a way to account for the effects of the cascade of technologies responsible for goods and services. It is limited to that, though, because the similar cascade of impacts from the commerce responsible for goods and services is unaccountable because what people do with money is unrecorded. As a consequence LCA succeeds in accurately measuring the impacts of the technology used for delivering products, but the whole impact of making the economic choice of using it.

The term 'life cycle' refers to the notion that a fair, holistic assessment requires the assessment of raw material production, manufacture, distribution, use and disposal including all intervening transportation steps necessary or caused by the product's existence. The sum of all those steps - or phases - is the life cycle of the product. The concept also can be used to optimize the environmental performance of a single product (ecodesign) or to optimize the environmental performance of a company. Common categories of assessed damages are global warming (greenhouse gases), acidification, smog, ozone layer depletion, eutrophication, eco-toxicological and human-toxicological pollutants, habitat destruction, desertification, land use as well as depletion of minerals and fossil fuels.

The procedures of life cycle assessment (LCA) are part of the ISO 14000 environmental management standards: in ISO 14040:2006 and 14044:2006. (ISO 14044 replaced earlier versions of ISO 14041 to ISO 14043.)

[edit] Four main phases

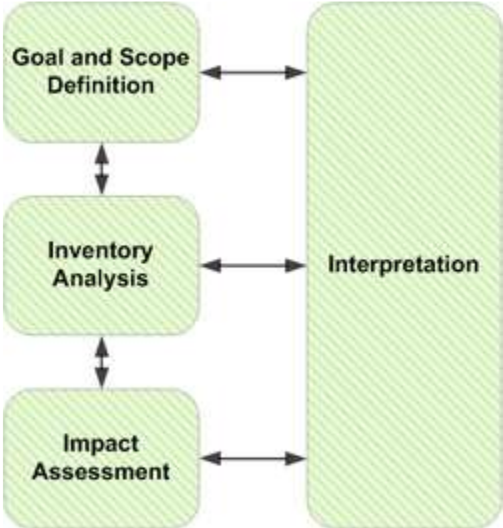

Illustration of LCA phases. These are often interdependent in that the results of one phase will inform how other phases are completed.

According to the ISO 14040[1] and 14044[2] standards, a Life Cycle Assessment is carried out in four distinct phases.

[edit] Goal and scope

In the first phase, the LCA-practitioner formulates and specifies the goal and scope of study in relation to the intended application. The object of study is described in terms of a so-called *functional unit*. Apart from describing the functional unit, the goal and scope should address the overall approach used to establish the system boundaries. The system boundary determines which unit processes are included in the LCA and must reflect the goal of the study. In recent years, two additional approaches to system delimitation have emerged. These are often referred to as 'consequential' modeling and 'attributional' modeling. Finally the goal and scope phase includes a description of the method applied for assessing potential environmental impacts and which impact categories that are included.

[edit] Life cycle inventory

This second phase 'Inventory' involves data collection and modeling of the product system, as well as description and verification of data. This encompasses all data related to environmental (e.g., CO2) and technical (e.g., intermediate chemicals) quantities for all relevant unit processes within the study boundaries that compose the product system. Examples of inputs and outputs quantities include inputs of materials, energy, chemicals and 'other' - and outputs in the form of air emissions, water emissions or solid waste. Other types of exchanges or interventions such as radiation or land use can also be included.

Usually Life Cycle Assessments inventories and modeling are carried out using dedicated software packages. Depending of the software package used it is possible to model life cycle costing and life cycle social impacts in parallel with environmental life cycle.

The data must be related to the functional unit defined in the goal and scope definition. Data can be presented in tables and some interpretations can be made already at this stage. The results of the inventory is an LCI which provides information about all inputs and outputs in the form of elementary flow to and from the environment from all the unit processes involved in the study.

[edit] Life cycle impact assessment

The third phase 'Life Cycle Impact Assessment' is aimed at evaluating the contribution to impact categories such as global warming, acidification, etc. The first step is termed characterization. Here, impact potentials are calculated based on the LCI results. The next steps are normalization and weighting, but these are both voluntary according the ISO standard. Normalization provides a basis for comparing different types of environmental impact categories (all impacts get the same unit). Weighting implies assigning a weighting factor to each impact category depending on the relative importance.

[edit] Interpretation

The phase stage 'interpretation' is the most important one. An analysis of major contributions, sensitivity analysis and uncertainty analysis leads to the conclusion whether the ambitions from the goal and scope can be met. More importantly: what can be learned from the LCA? All conclusions are drafted during this phase. Sometimes an independent critical review is necessary, especially when comparisons are made that are used in the public domain.

[edit] LCA uses and tools

Based on a survey of LCA practitioners carried out in 2006 [3] most life cycle assessments are carried out with dedicated software packages. 58% of respondents used GaBi Software[4], developed by PE International, 31% used SimaPro[5] developed by PRé Consultants[6], and 11% a series of other tools. According to the same survey, LCA is mostly used to support business strategy (18%) and R&D (18%), as input to product or process design (15%), in education (13%) and for labeling or product declarations (11%).

[edit] Variants

[edit] Cradle-to-grave

Cradle-to-grave is the full Life Cycle Assessment from manufacture ('cradle') to use phase and disposal phase ('grave'). For example, trees produce paper, which is recycled into low-energy production cellulose (fiberised paper) insulation, then used as an energy-saving device in the ceiling of a home for 40 years, saving 2,000 times the fossil-fuel energy used in its production. After 40 years the cellulose fibers are replaced and the old fibres are disposed of, possibly incinerated. All inputs and outputs are considered for all the phases of the life cycle.

[edit] Cradle-to-gate

Cradle-to-gate is an assessment of a *partial* product life cycle from manufacture ('cradle') to the factory gate (i.e., before it is transported to the consumer). The use phase and disposal phase of the product are usually omitted. Cradle-to-gate assessments are sometimes the basis for environmental product declarations (EPD).

[edit] Cradle-to-Cradle

Cradle-to-cradle is a specific kind of cradle-to-grave assessment, where the end-of-life disposal step for the product is a recycling process. From the recycling process originate new, identical products (e.g., glass bottles from collected glass bottles), or different products (e.g., glass wool insulation from collected glass bottles).

[edit] Gate-to-Gate

Gate-to-Gate is a partial LCA looking at only one value-added process in the entire production chain.

[edit] Well-to-wheel

Well-to-wheel is the specific LCA of the efficiency of fuels used for road transportation. The analysis is often broken down into stages such as "well-to-station" and "station-to-wheel, or "well-to-tank" and "tank-to-wheel".

The factor "T_p = Petroleum refining and distribution efficiency = 0.830" from the DOE regulation accounts for the "well-to-station" portion of the gasoline fuel cycle in the USA. To convert a standard Monroney sticker value to a full cycle energy equivalent, convert with T_p. For example, the Toyota Corolla is rated at 28 mpg station-to-wheel. To get the full cycle value, multiply mpg by Tp=0.83 to account for the refining and transportation energy use - **23.2 mpg full cycle**. The same adjustment applies to all vehicles fueled completely with gasoline, therefore, Monroney sticker numbers can be compared to each other with or without the adjustment. A recent study examined well-to-wheels energy and emission effects of various vehicle and fuel systems [1]

[edit] Economic Input-Output Life Cycle Assessment

EIOLCA, or Economic Input-Output LCA involves use of aggregate sector-level data on how much environmental impact can be attributed to each sector of the economy and how much each sector purchases from other sectors.[7] Such analysis can account for long chains (for example, building an automobile requires energy, but producing energy requires vehicles, and building those vehicles requires energy, etc.), which somewhat alleviates the scoping problem of process LCA; however, EIO-LCA relies on sector-level averages that may or may not be representative of the specific subset of the sector relevant to a particular product and therefore is not suitable for evaluating the environmental impacts of products.

Hybrid LCA describes approaches to blending data from EIO and process-based models. For example, one might use process LCA to capture all of the aspects that can be measured within the scope of the study and use EIOLCA to capture the supply chain outside of the system boundary.

[edit] Life cycle energy analysis

Life cycle energy analysis (LCEA) is an approach in which all energy inputs to a product are accounted for, not only direct energy inputs during manufacture, but also all energy inputs needed to produce components, materials and services needed for the manufacturing process. Early expression used for the approach is *energy analysis*.

With LCEA, the *total life cycle energy input* is established.

[edit] Energy production

It is recognized that much energy is lost in the production of energy commodities themselves, such as nuclear energy, photovoltaic electricity or high-quality petroleum products. *Net energy content* is the energy content of the product minus energy input used during extraction and conversion, directly or indirectly.

A controversial early result of LCEA claimed that manufacturing solar cells requires more energy than can be recovered in using the solar cell. The result was refuted.[*citation needed*]

Another new concept that flows from life cycle assessments is Energy Cannibalism. Energy Cannibalism refers to an effect where rapid growth of an entire energy-intensive industry creates a need for energy that uses (or cannibalizes) the energy of existing power plants. Thus during rapid growth the industry as a whole produces no energy because new energy is used to fuel the embodied energy of future power plants.

[edit] LCEA Criticism

A criticism of LCEA is that it attempts to eliminate monetary cost analysis, that is replace the currency by which economic decisions are made with an energy currency.[*citation needed*]

A problem the energy analysis method cannot resolve is that different energy forms (heat, electricity, chemical energy etc.) have different quality and value even in natural sciences, as a consequence of the two main laws of thermodynamics. A thermodynamic measure of the quality of energy is exergy. According to the first law of thermodynamics, all energy inputs should be accounted with equal weight, whereas by the second law diverse energy forms should be accounted by different values.

The conflict is resolved in one of these ways:

- value difference between energy inputs is ignored,
- a value ratio is arbitrarily assigned (e.g., a joule of electricity is 2.6 times more valuable than a joule of heat or fuel input),
- and/or the analysis is supplemented by economic (monetary) cost analysis.

[edit] Critiques

Life-cycle analysis is a powerful tool for analyzing commensurable aspects of quantifiable systems. Not every factor, however, can be reduced to a number and inserted into a model. Rigid system boundaries make accounting for changes in the system difficult. This is sometimes referred to as the boundary critique to systems thinking. Additionally, social implications of products are generally lacking in LCAs.

The Agroecology tool "agroecosystem analysis" offers a framework to incorporate incommensurable aspects of the life cycle of a product (such as social impacts, and soil and water implications)[8]. This tool is specifically useful in the analysis of a product made from agricultural materials such as corn ethanol or soybean biodiesel because it can account for an ecology of contexts interacting and changing through time. This analysis tool should not be used instead of life-cycle analysis, but rather, in conjunction with life-cycle analysis to produce a well-rounded assessment.

[edit] See also

- Enterprise carbon accounting

energy portal

Sustainable development portal

- Agroecology
- Agroecosystem analysis
- Anthropogenic metabolism
- Biofuel
- Carbon footprint
- Design for Environment
- End-of-life (product)
- Greenhouse gas
- GREET Model
- Industrial Ecology
- ISO 15686
- Environmental Value Engineering

[edit] References

1. ^ ISO 14040 (2006): Environmental management - Life cycle assessment -Principles and framework, International Organisation for Standardisation (ISO), Geneve
2. ^ ISO 14044 (2006): Environmental management - Life cycle assessment -Requirements and guidelines, International Organisation for Standardisation (ISO), Geneve
3. ^ Cooper, J.S., J. Fava "Life Cycle Assessment Practitioner Survey: Summary of Results," Journal of Industrial Ecology (2006)
4. ^ GaBi Software
5. ^ http://www.pre.nl/simapro/default.htm
6. ^ http://www.pre.nl/
7. ^ Hendrickson, C. T., Lave, L. B., and Matthews, H. S. (2005). *Environmental Life Cycle Assessment of Goods and Services: An Input-Output Approach*, Resources for the Future Press.

8. ^ *Bland, W.L. and Bell, M.M., (2007) A holon approach to agroecology *International Journal of Agricultural Sustainability* 5(4), 280-294. abstract available here

[edit] Further reading

1. Thomas,J.A.G., ed: *Energy Analysis*, ipc science and technology press & Westview Press, 1977, ISBN 0-902852-60-4 or ISBN 0-89158-813-2
2. M.W.Gilliland ed: *Energy Analysis: A New Public Policy Tool*, AAA Selected Symposia Series, Westview Press, Boulder, Colorado, 1978., ISBN 0-89158-437-4
3. Center for Life Cycle Analysis, Columbia University, New York www.clca.columbia.edu
4. J. Guinée, ed:, *Handbook on Life Cycle Assessment: Operational Guide to the ISO Standards*, Kluwer Academic Publishers, 2002.
5. Hendrickson, C. T., Lave, L. B., and Matthews, H. S. (2005). *Environmental Life Cycle Assessment of Goods and Services: An Input-Output Approach*, Resources for the Future Press.
6. Baumann, H. och Tillman, A-M. The hitchhiker's guide to LCA : an orientation in life cycle assessment methodology and application. 2004. ISBN 91-44-02364-2

[edit] External links

- UNEP/SETAC Life Cycle Initiative
- The European Commission's Directory of LCA services, tools and databases
- The European Commission's LCA database ELCD (free of charge)
- Life-cycle.org - links to LCA sites and resources.
- Department Life Cycle Engineering - LBP – University of Stuttgart.
- How Products Impact Natural Systems.
- Embodied Energy: Life Cycle Assessment. Your Home Technical Manual. A joint initiative of the Australian Government and the design and construction industries.
- LCA research at the Center for Environmental Sciences, Leiden University

[hide]

v • d • e

Topics in Industrial Ecology

Tools	Agent based modeling · Cost benefit analysis · DPSIR · Ecolabel · Ecological footprint · Environmental impact assessment · Environmental management system · Full cost accounting · Input-output analysis · Integrated chain management · ISO 14000 · Life cycle analysis · Life cycle costing · Material flow analysis · MET Matrix · Stakeholder analysis
Concepts	Cradle to cradle · Dematerialization · Eco-efficiency · Eco-industrial park · Ecological modernization · Efficient energy use · Exergy · Extended producer responsibility · Industrial metabolism · Industrial symbiosis · Pollution prevention · **Life cycle assessment** · Polluter

	pays principle · Precautionary principle · Rebound effect · Waste hierarchy · Waste minimisation
Related Fields	Cleaner Production · Design for Environment · Earth systems engineering and management · Ecological economics · Environmental economics · Green Chemistry · Sustainable Development
Examples	Ecopark · Kalundborg Eco-industrial Park · National Industrial Symbiosis Programme

Life Cycle Assessment (LCA)

Was bedeutet Life Cycle Assesment (LCA) ?

Das Life Cycle Assessment (LCA) ist ein Werkzeug, das zur Bewertung der möglichen Auswirkungen eines Produktes, eines Verfahrens oder einer Tätigkeit auf die Umwelt im Verlauf seiner gesamten Lebenszeit (Life cycle) verwendet wird, wobei die Verwendung bestimmter Ressourcen quantitativ bemessen wird ("Inputs", wie zum Beispiel Energie, Rohstoffe, Wasser) und die Emissionen in die Umwelt ("Outputs" in die Luft, ins Wasser und den Boden) beurteilt werden, die mit dem untersuchten System in Verbindung zu bringen sind.

Beim Life Cycle Assesment (LCA) wird für ein typisches Produkt berechnet, welche und wie viele Rohstoffe für die Herstellung des Produkts, die Herstellung von Zwischenprodukten und schließlich für das Produkt selbst, einschließlich Verpackung und Transport der Rohstoffe, der Zwischenprodukte und des Produkts, für die Verwendung des Produkts und seine Entsorgung nach der Verwendung erforderlich sind.

Die zwei Arten von Systemen, die für P&G von besonderem Interesse sind, sind zum einen die Lebensdauer eines Produktes (z.B. eines Waschmittels) oder einer Aktivität (wie zum Beispiel Wäschewaschen). Die Untersuchungen zur Lebensdauer werden durchgeführt, um bestimmte Fragen zu beantworten und daher sind diese Fragen für den Aufbau der LCA Studie entscheidend. Eine derartige Frage könnte beispielsweise folgende sein: welche Auswirkungen auf die Umwelt hat potenziell ein neues Produkt im Vergleich zu den Auswirkungen von Produkten, die bereits auf dem Markt sind? (Lesen Sie unsere LCA Fallstudien.).

Das LCA ist keine Risikobewertung

Dies darauf zurückzuführen, dass das LCA die Exposition nicht in Betracht zieht, die jedoch ein äußerst wichtiger Parameter für die Risikobewertung ist. Beim LCA werden Emissionen quantitativ bestimmt, die tatsächlichen Auswirkungen dieser Emissionen sind jedoch davon abhängig, wo und wann sie in die Umwelt abgegeben werden.

Das LCA ist eines der Instrumente aus unserem "Werkzeugkasten" zur Bewertung der Produkte, Verpackungen und Prozesse von P&G. Ferner gibt es noch folgende andere Instrumente, die an anderer Stelle beschrieben werden:

- Bewertung der Umweltrisiken
- Kosten/ Nutzen Analyse
- Vergleichende Risikoanalyse
- Analyse der Auswirkungen auf Gesellschaft und Wirtschaft

Warum wird das Life Cycle Assesment durchgeführt?

Das Life Cycle Assessment wird zur Beantwortung spezifischer Fragen verwendet, wie z.B. folgende:

- Vergleich zweier verschiedener Herstellungsprozesse desselben Produkts: inwieweit unterscheiden sie sich hinsichtlich ihres Verbrauchs von Ressourcen und ihrer Emissionen?
- Vergleich von Kompakt-Spülmitteln mit herkömmlichen Geschirrspülmitteln: inwieweit unterscheiden sie sich hinsichtlich ihres Verbrauchs von Ressourcen und ihrer Emissionen?
- Inwieweit tragen die verschiedenen Phasen in der gesamten Lebensdauer dieses Produktes anteilsmäßig zu den Gesamtemissionen bei?
- Analyse der Auswirkungen auf Gesellschaft und Wirtschaft

In anderen Worten versucht man mit dem Life Cycle Assessment die Effizienz zu steigern. Da beim Life Cycle Assessment alle "Lebensphasen" eines Produktes berücksichtigt werden, können offensichtliche Verbesserungen, die das Problem lediglich umgehen, erkannt und somit vermieden werden.

- Definitionen
- LCIA
- Fallstudien

http://www.scienceinthebox.com/de_DE/sustainability/lifecycleassessment_de.html

Fachstudium der Vertiefung Ökologisches Systemdesign und Entsorgungstechnik

Ab Wintersemester 2006/07:

Bachelor:

- Grundlagenvorlesung Oekologische Systemanalyse
- Seminar Umweltingenieurwissenschaften
- Abfalltechnik
- Methoden der Umweltingenieurwissenschaften (gemeinsam mit anderen Fachbereichen)

Master (Major Ecological Systems Design and Waste Management):

(Nur englische Vorlesungen)

- Advanced Environmental Assessments
- Landfilling, nuclear repositories and contaminated sites
- Implementation of Environmental Goals
- Sustainable Product Design
- Prospective Environmental Assessments
- Project Management: Planning Renewable Energy Projects
- Environment and Computer Laboratory I
- Environment and Computer Laboratory II

Herbstsemester 2008:

Bachelor Arbeiten

Master- / Diplomarbeiten

Poster Übersicht über das Studium mit Schwerpunkt Stoffhaushalt und Entsorgungstechnik / Ökologisches Systemdesign.

http://www.ifu.ethz.ch/ESD/education/index