**LIFE CYCLE ASSESSMENT**

Debalina Sengupta

Research Associate

Artie McFerrin Department of Chemical Engineering, Texas A&M University, College Station, TX 77843

[debalinasengupta@tamu.edu](mailto:debalinasengupta@tamu.edu)

**Introduction**

Life Cycle Assessment (LCA) can be defined as the "compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle". Thus, LCA is a tool which aids in the analysis of environmental burdens of products at various stages in their life cycle – from the extraction of resources, through the production of materials, product parts and the product itself, and the use of the product to the management after it is discarded, either by reuse, recycling or final disposal (also known as ‘cradle to the grave’).

The total system of unit processes involved in the life cycle of a product is called the "product system". LCA considers the entire life cycle of a product, from raw material extraction and acquisition, through energy and material production and manufacturing, to use and end of life treatment and final disposal. This entire life cycle approach ensures that a shift of potential environmental burden between life cycle stages is identified and possibly avoided. For sustainable manufacturing, a sub analysis of gate-to-gate may be done, which evaluates a product system within the boundaries of plant gate. Essentially, this captures all the inputs coming in at a plant gate, and all the outputs going out of the plant boundary. This method is effective when one has prior knowledge of the upstream and downstream life cycle stages to be of negligible importance.

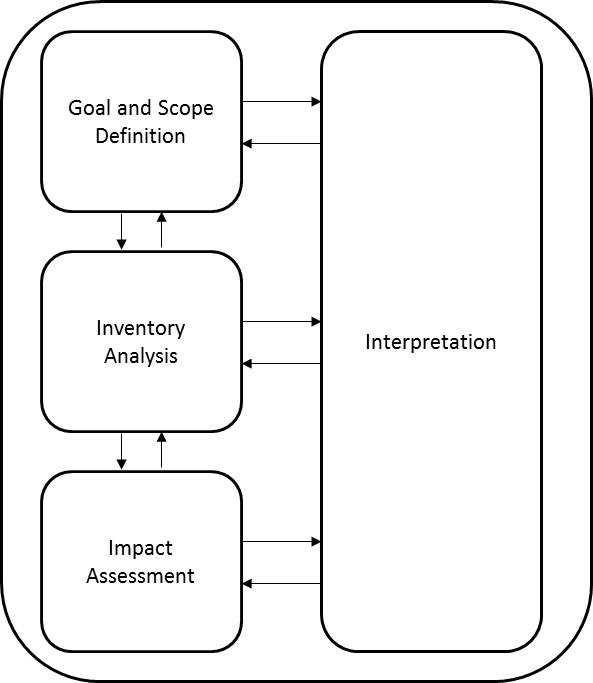
The environmental focus of LCA enables one to study the environmental aspects and impacts in its entirety, and its can be combined with other tools for assessing the economic and social aspects of sustainability. LCA is a relative approach structured around a functional unit, thereby enabling one to focus on either the stages of higher impact for a certain product system, or assessing the key impact areas for competing product systems. The success of LCA depends on the detail, transparency, and adhering to a scientific approach for data collection, data processing and interpretation of results.

Figure 1: Framework for Life Cycle Assessment

The ISO 14040:2006 and 14044:2006 standardizes the method for life cycle assessment. There are four phases in an LCA study: Goal and Scope Definition, Life Cycle Inventory Analysis (LCI), Life Cycle Impact Assessment (LCIA), and Interpretation (Figure 1). In Goal and Scope Definition, one needs to detail the reasons for carrying out the study, the intended application, and the intended audience. It is also the place where the system boundaries of the study are described and the functional unit is defined. The functional unit is a quantitative measure of the functions that the goods (or service) provide. The result from the LCI is a compilation of the inputs (resources) and the outputs (emissions) from the product over its life-cycle in relation to the functional unit. The LCIA is aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts of the studied system. In the Interpretation, the results from the previous phases are evaluated in relation to the goal and scope in order to reach conclusions and recommendations. Each phase is important in the proper evaluation of environmental impacts from a product’s life cycle. The figure 1 depicts these four stages of the LCA framework and is discussed in detail in the LCA theory section.

**Rationale: Life Cycle Assessment for ensuring Sustainable Engineering**

Knowledge of life cycle assessment is at the core of product or process engineering and an essential requirement for sustainable manufacturing. Life cycle assessment systematically incorporates environmental comparison between existing products and the development of new products, which also includes comparisons with prototypes. In traditional engineering disciplines, typically cost and economic parameters at the manufacturing stage of a particular product are used to make decisions about bringing a product to the market. An LCA study extends this approach by analyzing the potential environmental impact that a product can have at the manufacturing stage, and also comparing it with upstream production of the raw materials and downstream use and disposal of the final product. Thus, the product is placed into a perspective over its entire life-cycle, from cradle to grave when its life cycle assessment is conducted. This is also a core requirement for sustainability assessment of the product, and a life cycle perspective on the product’s life cycle is essential to design or reengineer products through sustainable engineering.

Life cycle assessment has two major users, manufacturers or policy makers. A manufacturer can use LCA for product development, improvement, or comparison. A policy maker in the public sector typically uses LCA for environmental labeling, more commonly known as eco-labeling. These two distinct uses make LCA an important accounting tool for ensuring sustainability of a particular product in the market.

**Course Content: LCA theory, methods, tools and databases**

LCA models the life cycle of a product as its product system. The product system can be broadly classified into the following stages of a) raw material acquisition, b) manufacturing of the product in the production subsystem, c) use of the product, and d) final disposal through waste treatment as shown in Figure 2. In addition to these subsystems, LCA also takes into account the environmental releases and potential impacts associated with transportation and energy use for the product system. The four stages of LCA are discussed in detail with relation to this product system.

**Goal and Scope Definition**

*Introduction*

The goal of an LCA states the intended application, detailed reasoning for the LCA study, the intended audience, and intended use of results. Since LCA is a comparative analytical method, the scope of the study should include the product system(s) to be studied, the functions of the product system(s), the functional unit, system boundary, allocation procedures, impact categories and methodology of impact assessment, data and data quality requirements, assumptions, limitations, and review and reporting method.

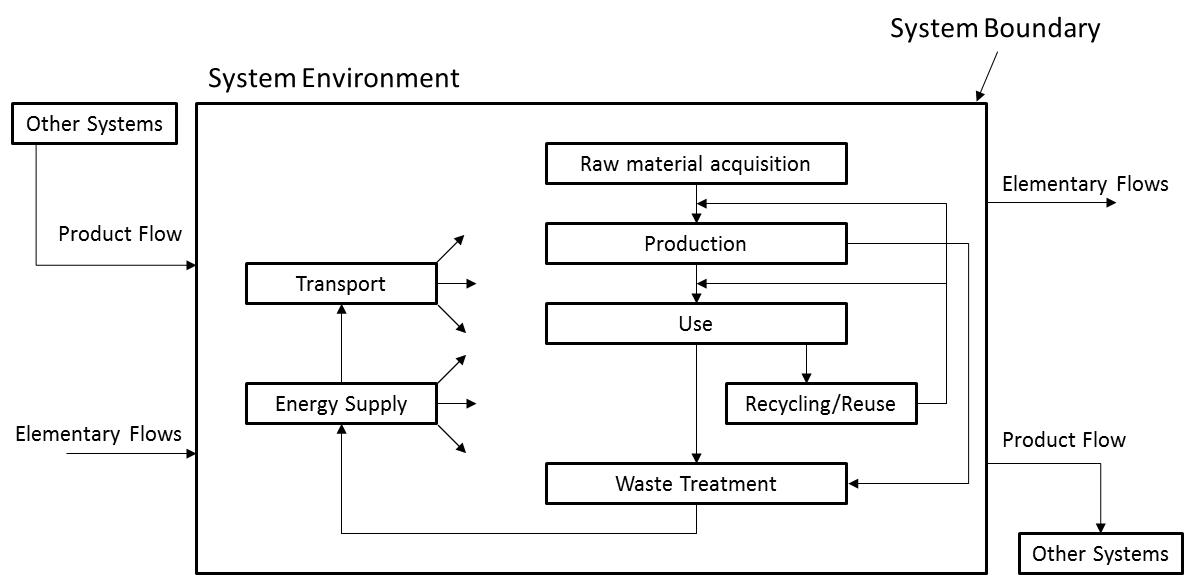


Figure 2: Product system in LCA

*Function, functional unit and reference flows*

One of the most important aspects of conducting an LCA study is the definition of the function, functional unit, and reference flow associated with the product system. A system may have several functions, and the goal and scope of the LCA determines the function required for analysis. The functional unit defines the quantification of the identified functions of the product so that the inputs and outputs can be related to a reference. The reference is necessary for comparability of LCA results. The reference flow in each product system is needed to fulfill the intended function, i.e. the amount of products needed for a certain function.

*System Boundary*

For a product system, it is comprised of subsystems which are known as unit processes. For a particular product system, a combination of unit processes is responsible for the function to be performed. The system boundary defines the unit processes to be included in the system for the LCA study.

**Life Cycle Inventory**

*Introduction*

Following the goal and scope definition, Inventory analysis involves data collection and calculation procedures to quantify relevant inputs and outputs of a product system. The process of conducting an inventory analysis is iterative. As data are collected and more is learned about the system, new data requirements or limitations may be identified that require a change in the data collection procedures so that the goals of the study will still be met. Sometimes, issues may be identified that require revisions to the goal or scope of the study.

*Data Collection*

Each unit process or subsystem within the product system needs to be constructed using data. Data for each unit process within the systems boundary can be classified as inputs (energy, raw material, ancillary, or other physical measures), products, co-products and waste, emissions to air, discharges to water and soil, and other environmental aspects. The data collection is a resource-intensive process, and often is the most time consuming stage for an LCA study. The practical constraints on data collection should be considered in the scope and documented in the study report as this will determine the validity of the interpreted results.

*Data Calculation*

Following the data collection, the data should be processed to ensure:

* Data collected is validated,
* The data is related to the unit processes, and
* The data is related to the reference flow of the functional unit,

Various sources of data may be needed to generate the results of the inventory of the defined system for each unit process and for the defined functional unit of the product system that is to be modelled.

The calculation of energy flows should take into account the different fuels and electricity sources used, the efficiency of conversion and distribution of energy flow, and the inputs and outputs associated with the generation and use of that energy flow.

*Allocation of Flows and Releases*

In most industrial processes, more than one product is produced which uses the resources into the process. This poses a problem of allocating the inputs and outputs from the unit process to the product of interest. There are primarily two ways to deal with multifunctional processes. The first is to allocate (partition) the inputs and environmental impacts between the products. This partitioning can be based on several principles like physical or chemical causation or economic value. It can also be based on an arbitrary choice of mass or energy content of the end products. The second way to treat allocation issues is to avoid it through division of the system into further subprocesses, such that the system boundary expansion is also accommodated as a result of such approach.

**Life Cycle Impact Assessment**

*Introduction*

The impact assessment phase of LCA is aimed at evaluating the significance of potential environmental impacts using the life cycle inventory results. In general, this process involves associating inventory data with specific environmental impact categories and category indicators, thereby attempting to understand these impacts. The LCIA phase also provides information for the life cycle interpretation phase. The impact assessment may include the iterative process of reviewing the goal and scope of the LCA study to determine if the objectives of the study have been met, or to modify the goal and scope if the assessment indicates that they cannot be achieved. Issues such as choice, modelling and evaluation of impact categories can introduce subjectivity into the LCIA phase. Therefore, transparency is critical to the impact assessment to ensure that assumptions are clearly described and reported.

The LCIA phase includes three distinct elements addressing a certain impact. These are:

1. Selection of impact categories and classification
2. Selection of characterization methods and characterization
3. Normalization
4. Grouping or weighting of impact categories

The separation into these individual elements is needed to distinctly define and study the product system. Some of the LCIA methods available in common LCA tools are AADP, CML 2001, EDIP 2003, Impact 2002+, ReCiPe, TRACI 2.1, UBP 2006, USEtox, and Eco-Indicator 99.

**Life Cycle Interpretation**

Interpretation is the phase of LCA in which the findings from the inventory analysis and the impact assessment are considered together or, in the case of LCI studies, the findings of the inventory analysis only. The interpretation phase should deliver results that are consistent with the defined goal and scope and which reach conclusions, explain limitations and provide recommendations. The interpretation should reflect the fact that the LCIA results are based on a relative approach, that they indicate potential environmental effects, and that they do not predict actual impacts on category endpoints, the exceeding of thresholds or safety margins or risks. The findings of this interpretation may take the form of conclusions and recommendations to decision-makers, consistent with the goal and scope of the study.

Life cycle interpretation is also intended to provide a readily understandable, complete and consistent presentation of the results of an LCA, in accordance with the goal and scope definition of the study.

The interpretation phase may involve the iterative process of reviewing and revising the scope of the LCA, as well as the nature and quality of the data collected in a way which is consistent with the defined goal.

The findings of the life cycle interpretation should reflect the results of the evaluation element.

**Reporting and Critical Review**

A reporting strategy is an integral part of an LCA. An effective report should address the different phases of the study under consideration. The key elements needed for reporting an LCA study must be directed to the intended audience and adequately address the data, methods and assumptions applied in the study. It is also important to explicitly define the limitations of the study.

If the study extends to the LCIA phase and is reported to a third-party, the following issues should be reported:

* the relationship with the LCI results;
* a description of the data quality;
* the category endpoints to be protected;
* the selection of impact categories;
* the characterization models;
* the factors and environmental mechanisms;
* the indicator results profile.

The relative nature of the LCIA results and their inadequacy to predict impacts on category endpoints should also be addressed in the report, including reference and description of value choices used in the LCIA phase of the study in relation to characterization models, normalization, weighting, etc.

This should be followed by a critical review by internal or external expert, or by a panel of interested parties.

**Tools and Databases for conducting Life Cycle Assessment**

The life cycle assessment theory has been applied for several product systems. This has led to the development of generic life cycle inventories captured in LCA databases, and tools which access data from these databases to conduct the impact assessment and interpretation of results. Some of the common LCA databases and tools are discussed in this section. Please note that the complexity of the Life Cycle Inventory determines which tool will be used. At its simplest, Microsoft Excel® can be used as a tool for assessing the LCA of a product.

**Life Cycle Assessment Databases**

A complete list of LCA databases is given in Appendix 1. The most common and widely used datasets for life cycle inventory are Ecoinvent (Ecoinvent Centre) and GaBi (PE International). Apart from this, the US LCI (NREL), ELCD (EC JRC), IO Databases (e.g. EIO-LCA) are also used in the LCA tools. The commercial databases are compared in the table below.

|  |  |  |
| --- | --- | --- |
|  | Ecoinvent | GaBi |
| No. of unit processes | ~4500 | 4000+ |
| Scope issues | Better coverage of infrastructure and transport inputs |  |
| Aggregation of data | Very little (plastics) | Highly |
| Sources | Mixed; most from statistical abstracts; some from industry | More direct from industry |
| US coverage | Limited | Better with US edition |
| Documentation | Public; all unit process data published; sources published; authors with contact info included | Public metadata and process model; hide inputs and outputs; calculation assumptions not published |
| Uncertainty | For all inputs based on transparent but semi-quantitative procedure | Not always quantified |
| Format | Ecospold 1.2 | ILCD, 1.1 (for all?) |
| Last update | V2.2, 2010 | 2006 (smaller updates with software) |

**Life Cycle Assessment Tools**

A complete list of LCA tools is given in Appendix 2. The most commonly used commercially available LCA tools are SimaPro 7 (PRé Consultants) and GaBi (PE International). Apart from this, OpenLCA (GreenDelta) is an LCA tool available free of cost. The comparison among these three software tools is given below.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Open-LCA | SimaPro | GaBi |
| **User base** | Mixed but small | Academia | Academia, Industry, DOE |
| **Visualization** | Process-based – flexible | Result-based | Process-based/Result-based |
| **Technical support** | Least capacity | Good | Excellent, but expensive |
| **Modelling issues** | Highly flexible | Limited treatment of recycling loops | More advanced treatment of recycling loops |

**Uncertainties and Limitations of LCA Methodology**

LCA is a mature tool with a well-established set of methods and data that enables a direct comparison of alternatives associated with the analyzed product or technology various goods and services. However, even with well-established data, including extensive data quality procedures, LCA is still subject to limitations that should be considered within the sustainability context. Unless data is collected specifically for a certain system for all the unit processes, LCA usually models “average” systems, and may not capture the impacts of policies that cause indirect changes or significant (non-marginal) changes in the market. For example, a shift in energy supply may affect power plant operations, and a new technology may create new demand (or eliminate demand) for other technologies. Additionally, the temporal and spatial detail of an LCA study may not provide sufficient granularity for some of the impact categories being considered.

With respect to LCA data, gaps in the availability of inventory data represent a barrier to LCA practice; data have not yet been assembled for some products, systems, and emissions (e.g., water use data can be limited even for well-understood systems). Filling data gaps requires significant effort, causing typical LCA studies to require many months to complete; however some streamlined alternatives to full LCA are available, such as Cumulative Energy Demand (CED), which focuses solely on energy. CED is a screening impact indicator to provide information on potential product environmental impacts and estimation of energy resource depletion by capturing direct and indirect energy use/demand during the complete life-cycle. Data to quantify CED may be more readily available than the data needed to conduct a full LCA, as less information is required; emission estimates/factors and impact assessment factors are not required. However, CED does not address issues such as water, land use, or pollution that are key to a full sustainability assessment.

For the LCIA phase, it addresses only the environmental issues that are specified in the goal and scope. Therefore, LCIA is not a complete sustainability assessment tool, and often it does not include all environmental issues of the product system under study.

LCIA cannot always demonstrate significant differences between impact categories and the related indicator results of alternative product systems. This may be due to a) limited development of the characterization models, sensitivity analysis and uncertainty analysis for the LCIA phase, b) limitations of the LCI phase, such as setting the system boundary, that do not encompass all possible unit processes for a product system or do not include all inputs and outputs of every unit process, since there are cut-offs and data gaps, c) limitations of the LCI phase, such as inadequate LCI data quality which may, for instance, be caused by uncertainties or differences in allocation and aggregation procedures, and d) limitations in the collection of inventory data appropriate and representative for each impact category.

The lack of spatial and temporal dimensions in the LCI results introduces uncertainty in the LCIA results. The uncertainty varies with the spatial and temporal characteristics of each impact category. There are no generally accepted methodologies for consistently and accurately associating inventory data with specific potential environmental impacts. Models for impact categories are in different stages of development.

**Connections to Existing Core Curriculum**

LCA is an important method for analysis of products, extending its reach to the study of process systems. Thus, it can be integrated into several systems based analytical studies at a screening level. In the core curriculum, the LCA module should be introduced in courses on process design and simulation, environmental fate and transport, and other relevant areas. In fact, an idea of LCA is extremely valuable for all engineering core courses, as building an inventory is directly related to sound understanding of engineering principles, and forms the basis for an effective life cycle impact assessment.

**References and Relevant Literature**

ISO, ISO14040. "14040: Environmental Management–Life Cycle Assessment–Principles and Framework." *London: British Standards Institution* (2006).

Finnveden, Göran, et al. "Recent developments in life cycle assessment." Journal of environmental management 91.1 (2009): 1-21.

Bare, J. C.; Norris, G. A.; Pennington, D. W.; McKone, T., TRACI - The Tool for the Reduction and Assessment of Chemical and other environmental Impacts. Journal of Industrial Ecology 2003, 6, (3), 49-78. http://onlinelibrary.wiley.com/doi/10.1162/108819802766269539/abstract

Bare, J., TRACI 2.0: the tool for the reduction and assessment of chemical and other environmental impacts 2.0. Clean Technologies and Environmental Policy 2011, 13, (5). http://link.springer.com/article/10.1007/s10098-010-0338-9#page-1

Bare, J. C. Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI), Software Name and Version Number: TRACI Version 2.1 - User's Manual; 2012.

Guinée, Jeroen B. "Handbook on life cycle assessment operational guide to the ISO standards." The international journal of life cycle assessment 7.5 (2002): 311-313.

Baumann, Henrikke, and Anne-Marie Tillman. The Hitch Hiker's Guide to LCA. An orientation in life cycle assessment methodology and application. External organization,, 2004.

Curran, Mary Ann. "Environmental life-cycle assessment." The International Journal of Life Cycle Assessment 1.3 (1996): 179-179.

Curran, Mary Ann, ed. Life cycle assessment handbook: a guide for environmentally sustainable products. John Wiley & Sons, 2012.

*LCA Software and Video Links to LCA orientation*

http://my.brainshark.com/Search.aspx?slice=1&searchtext=epa%20lca

<http://www.pre-sustainability.com/simapro>

<http://www.gabi-software.com/america/index/>

<http://www.gabi-software.com/america/support/gabi-learning-center/gabi-6-learning-center/>

**Appendix 1**

List of LCA Databases (http://eplca.jrc.ec.europa.eu/ResourceDirectory/databaseList.vm)

| Database | Developer | Supplier | ILCD Compliant | ILCD Entry Level | PEF/OEF | Database Languages |
| --- | --- | --- | --- | --- | --- | --- |
| EIME Electric and Electronics 2014-03 | Bureau Veritas CODDE | Bureau Veritas CODDE | Yes | Yes | Yes | English |
| EIME Generic 2014-03 | Bureau Veritas CODDE | Bureau Veritas CODDE | Yes | No | Yes | Spanish, French, English |
| EIME Marine 2014-03 | Bureau Veritas CODDE | Bureau Veritas CODDE | Yes | Yes | No | English |
| EIME Textile 2014-03 | Bureau Veritas CODDE | Bureau Veritas CODDE | Yes | Yes | Yes | English |
| ESU data-on-demand 2014 | ESU-services Ltd. | ESU-services Ltd. | Yes | Yes | Yes | German, English |
| LC-inventories 2014 | ESU-services Ltd. | ESU-services Ltd. | Yes | Yes | Yes | English |
| C-BUILD e-LICCO 1.2 | CYCLECO | CYCLECO | No | No | No | French |
| C-FOOD 1.0 | CYCLECO | CYCLECO | No | No | No | French, English |
| C-TEX 1.0 | CYCLECO | CYCLECO | No | No | No | French, English |
| CPM LCA Database | Center for Environmental Assessment of Product and Material Systems - CPM | Center for Environmental Assessment of Product and Material Systems - CPM | No | No | No | English |
| DEAM™ | Ecobilan - PricewaterhouseCoopers | Ecobilan - PricewaterhouseCoopers | No | No | No | English |
| DEAM™ Impact | Ecobilan - PricewaterhouseCoopers | Ecobilan - PricewaterhouseCoopers | No | No | No | English |
| DIM 1.0 | ENEA - Italian National Agency for New Technology, Energy and the Environment | ENEA - Italian National Agency for New Technology, Energy and the Environment | No | No | No | Italian, English |
| ECODESIGN X-Pro database V1.0 | EcoMundo | EcoMundo | No | No | No | English |
| ecoinvent Data v1.3 | ecoinvent Centre | PE INTERNATIONAL , Quantis - Sustainability counts , ecoinvent Centre , FEBE ECOLOGIC , PRé Consultants B.V. , sinum AG ,2B , | No | No | No | Japanese, English |
| Eurofer data sets | EUROFER | EUROFER | No | No | No | English |
| GEMIS 4.4 | Oeko-Institut (Institute for applied Ecology), Darmstadt Office | Oeko-Institut (Institute for applied Ecology), Darmstadt Office | No | No | No | Spanish, Czech, German, English |
| IO-database for Denmark 1999 | 2.-0 LCA consultants | 2.-0 LCA consultants , PRé Consultants B.V. | No | No | No | English |
| IVAM LCA Data 4.04 | IVAM University of Amsterdam bv | IVAM University of Amsterdam bv | No | No | No | English |
| KCL EcoData | Oy Keskuslaboratorio-Centrallaboratorium Ab, KCL | Oy Keskuslaboratorio-Centrallaboratorium Ab, KCL | No | No | No | English |
| LC Data | Forschungszentrum Karlsruhe | Forschungszentrum Karlsruhe | No | No | No | German, English |
| LCA Database for the Forest Wood Sector | Bundesforschungsanstalt für Forst- und Holzwirtschaft (BFH) | Bundesforschungsanstalt für Forst- und Holzwirtschaft (BFH) | No | No | No |  |
| LCA\_sostenipra\_v.1.0 | Universitat Autònoma de Barcelona (UAB) | Universitat Autònoma de Barcelona (UAB) | No | No | No | Spanish, Catalan, English |
| MFA\_sostenipra\_v.1.0 | Universitat Autònoma de Barcelona (UAB) | Universitat Autònoma de Barcelona (UAB) | No | No | No | Spanish, Catalan, English |
| Option data pack | National Institute of Advanced Industrial Science and Technology (AIST) | National Institute of Advanced Industrial Science and Technology (AIST) | No | No | No | Japanese |
| PlasticsEurope Eco-profiles | PlasticsEurope | PlasticsEurope | No | No | No | English |
| ProBas | Umweltbundesamt | Umweltbundesamt | No | No | No | German |
| Sabento library 1.1 | ifu Hamburg GmbH | ifu Hamburg GmbH | No | No | No | German, English |
| SALCA 061 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | No | No | No | German, English |
| SALCA 071 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | No | No | No | German, English |
| SimaPro database | PRé Consultants B.V. | PRé Consultants B.V. | No | No | No | English |
| sirAdos 1.2. | LEGEP Software GmbH | LEGEP Software GmbH | No | No | No | German |
| The Boustead Model 5.0.12 | Boustead Consulting Limited | Boustead Consulting Limited | No | No | No | English |
| Umberto library 5.5 | ifu Hamburg GmbH | ifu Hamburg GmbH | No | No | No | German, English |
| US Life Cycle Inventory Database | Athena Sustainable Materials Institute | Athena Sustainable Materials Institute | No | No | No | English |
| Waste Technologies Data Centre | UK Environment Agency | UK Environment Agency | No | No | No | English |

**Appendix 2**

List of LCA Tools (http://eplca.jrc.ec.europa.eu/ResourceDirectory/toolList.vm)

| Tool + version | Developer | Supplier | Instruments | ILCD Compliant | ILCD Entry Level | PEF/OEF | Languages of Interface |
| --- | --- | --- | --- | --- | --- | --- | --- |
| AirConLCA | Centre for Water and Waste Technology | Centre for Water and Waste Technology |  | No | No | No | English |
| AIST-LCA Ver.4 | National Institute of Advanced Industrial Science and Technology (AIST) | National Institute of Advanced Industrial Science and Technology (AIST) | Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA), Product stewardship, supply chain management | No | No | No | Japanese |
| BEES 3.0d | National Institute of Standards and Technology (NIST) | National Institute of Standards and Technology (NIST) | Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA), Life cycle costing (LCC) | No | No | No | English |
| DPL 1.0 | IVAM University of Amsterdam bv | IVAM University of Amsterdam bv |  | No | No | No | Dutch |
| e!Sankey 1.0 | ifu Hamburg GmbH | ifu Hamburg GmbH | Life cycle management (LCM), Life cycle inventory (LCI), Life cycleengineering (LCE), Life cycle assessment (LCA), Substance/material flow analysis (SFA/MFA), Design for environment (DfE, DfR), Life cycle sustainability assessment (LCS), Life cycle costing (LCC) | No | No | No | English |
| Eco-Bat 2.1 | Haute Ecole d'Ingénierie et de Gestion du Canton de Vaud | Haute Ecole d'Ingénierie et de Gestion du Canton de Vaud | Life cycle impact assessment (LCIA), Design for environment (DfE, DfR) | No | No | No | French, Italian, English |
| ECODESIGN X-Pro v1.0 | EcoMundo | EcoMundo | Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA), Legal Complience checks | No | No | No | English |
| ecoinvent waste disposal inventory tools v1.0 | Doka Life Cycle Assessments (Doka Okobilanzen) | Doka Life Cycle Assessments (Doka Okobilanzen) | Life cycle inventory (LCI) | No | No | No | English |
| Eco-Quantum | IVAM University of Amsterdam bv | IVAM University of Amsterdam bv |  | No | No | No | Dutch |
| EcoScan 3.1 | TNO Built Environment & Geosciences | TNO Built Environment & Geosciences | Life cycle impact assessment (LCIA), Design for environment (DfE, DfR) | No | No | No | Spanish, German, Dutch, English |
| e-LICCO | CYCLECO | CYCLECO | Life cycle assessment (LCA) | No | No | No | French |
| Environmental Impact Estimator V3.0.2 | Athena Sustainable Materials Institute | Athena Sustainable Materials Institute | Life cycle impact assessment (LCIA), Life cycle assessment (LCA), Design for environment (DfE, DfR) | No | No | No | English |
| EPD Tools Suit 2007 | ITKE Enviornmental Technology Inc. | ITKE Enviornmental Technology Inc. | Life cycle inventory (LCI) | No | No | No | Chinese |
| eVerdEE v.1.0 | ENEA - Italian National Agency for New Technology, Energy and the Environment | ENEA - Italian National Agency for New Technology, Energy and the Environment | Life cycle management (LCM), Life cycle assessment (LCA), Design for environment (DfE, DfR) | No | No | No | Spanish, Italian, German, English |
| eVerdEE v.2.0 | ENEA - Italian National Agency for New Technology, Energy and the Environment | ENEA - Italian National Agency for New Technology, Energy and the Environment | Life cycle management (LCM), Life cycle assessment (LCA), Design for environment (DfE, DfR) | No | No | No | Italian, English |
| Food'Print | CYCLECO | CYCLECO | Life cycle assessment (LCA) | No | No | No | French, English |
| GaBi Envision | PE INTERNATIONAL | PE INTERNATIONAL FEBE ECOLOGIC | Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA), Substance/material flow analysis (SFA/MFA), Design for environment (DfE, DfR), Product stewardship, supply chain management | No | No | No | Spanish, Portuguese, English |
| GaBi Software | PE INTERNATIONAL LBP, University of Stuttgart (former IKP) | FEBE ECOLOGIC PE INTERNATIONAL LCA Center Denmark | social LCA, Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycleengineering (LCE), Life cycle assessment (LCA), Substance/material flow analysis (SFA/MFA), Design for environment (DfE, DfR), Legal Complience checks, Product stewardship, supply chain management, Life cycle sustainability assessment (LCS), Life cycle costing (LCC), Other - please specify | No | No | No | Japanese, Spanish, Portuguese, French, Thai, Italian, Chinese, German, English |
| GEMIS version 4.4 | Oeko-Institut (Institute for applied Ecology), Darmstadt Office | Oeko-Institut (Institute for applied Ecology), Darmstadt Office |  | No | No | No | Spanish, Czech, German, English |
| Green-E, version 1.0 | Quantis - Sustainability counts | Quantis - Sustainability counts | social LCA, Life cycle management (LCM), Life cycle assessment (LCA), Design for environment (DfE, DfR), Life cycle sustainability assessment (LCS), Life cycle costing (LCC) | No | No | No | English |
| JEMAI-LCA Pro ver.2 | Japan Environmental Management Association for Industry (JEMAI) | Japan Environmental Management Association for Industry (JEMAI) | Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA) | No | No | No | Japanese, English |
| KCL-ECO 4.0 | Oy Keskuslaboratorio-Centrallaboratorium Ab, KCL | Oy Keskuslaboratorio-Centrallaboratorium Ab, KCL | Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycleengineering (LCE), Life cycle assessment (LCA), Substance/material flow analysis (SFA/MFA), Design for environment (DfE, DfR), Product stewardship, supply chain management | No | No | No | English |
| Key parameter model for energy systems | ESU-services Ltd. | ESU-services Ltd. |  | No | No | No | French, German |
| LCA - Evaluator 2.0 | GreenDeltaTC GmbH | GreenDeltaTC GmbH | Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycle assessment (LCA) | No | No | No | English |
| LEGEP 1.2 | LEGEP Software GmbH | LEGEP Software GmbH | social LCA, Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycleengineering (LCE), Life cycle assessment (LCA), Design for environment (DfE, DfR), Life cycle sustainability assessment (LCS), Life cycle costing (LCC) | No | No | No | Italian, German |
| LTE OGIP; Version 5.0; Build-Number 2092; 2005/12/12 | t.h.e. Software GmbH | t.h.e. Software GmbH | Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA), Design for environment (DfE, DfR), Life cycle costing (LCC) | No | No | No | German |
| Modular MSWI Model 1.0 | GreenDeltaTC GmbH | GreenDeltaTC GmbH | Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycleengineering (LCE), Life cycle assessment (LCA), Substance/material flow analysis (SFA/MFA), Design for environment (DfE, DfR), Life cycle costing (LCC) | No | No | No | English |
| Prototype Demolition Waste Decision Tool 1 | IVAM University of Amsterdam bv | IVAM University of Amsterdam bv | Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA), Design for environment (DfE, DfR), Product stewardship, supply chain management | No | No | No | Dutch |
| REGIS 2.3 | sinum AG | sinum AG | Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA), Substance/material flow analysis (SFA/MFA), Legal Complience checks, Life cycle sustainability assessment (LCS), Life cycle costing (LCC) | No | No | No | Japanese, Spanish, German, English |
| Sabento 1.1 | ifu Hamburg GmbH | ifu Hamburg GmbH | Life cycle management (LCM), Life cycle inventory (LCI), Life cycleengineering (LCE), Substance/material flow analysis (SFA/MFA), Design for environment (DfE, DfR), Product stewardship, supply chain management, Life cycle sustainability assessment (LCS), Life cycle costing (LCC) | No | No | No | German, English |
| SALCA-animal 1.0 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle inventory (LCI) | No | No | No | German |
| SALCA-biodiversity 061 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle impact assessment (LCIA), Life cycle inventory (LCI) | No | No | No | German |
| SALCA-biodiversity 1.0 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle impact assessment (LCIA), Life cycle inventory (LCI) | No | No | No | German |
| SALCA-crop 061 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA) | No | No | No | German |
| SALCA-crop 2.02 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA) | No | No | No | German |
| SALCA-erosion 061 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle inventory (LCI) | No | No | No | German |
| SALCA-erosion 2.0 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle inventory (LCI) | No | No | No | German |
| SALCA-farm 1.31 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA) | No | No | No | German |
| SALCA-farm 2.1 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA) | No | No | No | German |
| SALCA-heavy metals 061 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle inventory (LCI) | No | No | No | German |
| SALCA-heavy metals 1.0 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle inventory (LCI) | No | No | No | German |
| SALCA-nitrate 061 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle inventory (LCI) | No | No | No | German |
| SALCA-nitrate 4.0 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle inventory (LCI) | No | No | No | German |
| SALCA-soil quality 061 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle impact assessment (LCIA), Life cycle inventory (LCI) | No | No | No | German |
| SALCA-soil quality 1.1 | Agroscope Reckenholz-Tänikon Research Station ART | Agroscope Reckenholz-Tänikon Research Station ART | Life cycle impact assessment (LCIA), Life cycle inventory (LCI) | No | No | No | German |
| SankeyEditor 3.0 | STENUM GmbH | STENUM GmbH |  | No | No | No | English |
| SimaPro | ESU-services Ltd. | ESU-services Ltd. |  | Yes | Yes | No | French, German, English |
| SimaPro 7 | PRé Consultants B.V. | 2B PRé Consultants B.V. | social LCA, Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycleengineering (LCE), Life cycle assessment (LCA), Substance/material flow analysis (SFA/MFA), Design for environment (DfE, DfR), Product stewardship, supply chain management, Life cycle sustainability assessment (LCS), Life cycle costing (LCC) | No | No | No | Japanese, Spanish, Danish, Greek, French, Italian, German, Dutch, English |
| Spin'it | CYCLECO | CYCLECO | Life cycle inventory (LCI), Life cycle assessment (LCA) | No | No | No | French, German, English |
| STAN 1.1.3 - Software for Substance Flow Analysis | Vienna University of Technology | Vienna University of Technology | Substance/material flow analysis (SFA/MFA) | No | No | No | German, English |
| TEAM™ 4.5 | Ecobilan - PricewaterhouseCoopers | Ecobilan - PricewaterhouseCoopers | Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA), Substance/material flow analysis (SFA/MFA), Design for environment (DfE, DfR), Legal Complience checks, Product stewardship, supply chain management, Life cycle costing (LCC) | No | No | No | English |
| TEAM™ Web Simulator | Ecobilan - PricewaterhouseCoopers | Ecobilan - PricewaterhouseCoopers | Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA), Design for environment (DfE, DfR), Product stewardship, supply chain management, Life cycle costing (LCC) | No | No | No |  |
| TESPI | ENEA - Italian National Agency for New Technology, Energy and the Environment | ENEA - Italian National Agency for New Technology, Energy and the Environment | Design for environment (DfE, DfR) | No | No | No | Italian, English |
| The Boustead Model 5.0.12 | Boustead Consulting Limited | Boustead Consulting Limited | Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA) | No | No | No | English |
| trainEE | GreenDeltaTC GmbH | GreenDeltaTC GmbH | Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycleengineering (LCE), Life cycle assessment (LCA), Substance/material flow analysis (SFA/MFA), Design for environment (DfE, DfR), Product stewardship, supply chain management, Life cycle costing (LCC) | No | No | No | English |
| Umberto 5.5 | ifu Hamburg GmbH | ifu Hamburg GmbH | Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycleengineering (LCE), Life cycle assessment (LCA), Substance/material flow analysis (SFA/MFA), Product stewardship, supply chain management, Life cycle sustainability assessment (LCS), Life cycle costing (LCC) | No | No | No | English |
| USES-LCA | Radboud University Nijmegen | Radboud University Nijmegen | Life cycle impact assessment (LCIA) | No | No | No | English |
| Verdee | ENEA - Italian National Agency for New Technology, Energy and the Environment | ENEA - Italian National Agency for New Technology, Energy and the Environment | Life cycle management (LCM), Design for environment (DfE, DfR) | No | No | No | Italian |
| WAMPS, betaversion | IVL Swedish Environmental Research Institute Ltd | IVL Swedish Environmental Research Institute Ltd |  | No | No | No | English |
| WISARD 4.0 | Ecobilan - PricewaterhouseCoopers | Ecobilan - PricewaterhouseCoopers | Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA), Product stewardship, supply chain management, Life cycle costing (LCC) | No | No | No | French, English |
| WRATE | UK Environment Agency | UK Environment Agency | Life cycle management (LCM), Life cycle impact assessment (LCIA), Life cycle inventory (LCI), Life cycle assessment (LCA), Life cycle sustainability assessment (LCS) | No | No | No | English |