EeBGuide

Contract No. 285490

EeBGuide

Operational guidance for Life Cycle Assessment studies of the Energy Efficient Buildings Initiative

SEVENTH FRAMEWORK PROGRAMME

COORDINATION AND SUPPORT ACTION

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RE	Restricted to a group specified by the consortium (incl. the Commission Services)	
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SEVENTH FRAMEWORK PROGRAMME

E2B EI Energy Efficient Buildings

What is EeBGuide?

The European research project "EeBGuide" develops metrics and guidance for the preparation of Life Cycle Assessment (LCA) studies for energy-efficient buildings and building products. Ongoing research under the framework of the Energy Efficient Building European Initiative creates technologies for an energy-efficient Europe. LCA is used to assess the environmental benefits of new technologies. The EeBGuide manuals and guidance will support LCA practitioners to obtain comparative results in their work.

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Executive Summary

Operational guidance for Life Cycle Assessment studies of the Energy Efficient Buildings Initiative (EeBGuide) is a European Commission funded project aiming to produce expert guidance for conducting Life Cycle Assessment (LCA) studies for energy-efficient buildings and building products under the framework of Energy-efficient Building European Initiative (E2B EI).The EeBGuide guidance document will provide a common methodology supporting reliable assessment and comparison of new efficient buildings and products. It will support LCA practitioners in industry and research.

In order to ensure acceptance by LCA practitioners, the EeBGuide was developed with a strong focus on applicability. Therefore, stakeholders and LCA experts were involved from the beginning, describing questions and problems that usually appear while conducting an LCA study.

The critical questions and problems suggested by stakeholders and LCA experts were collected and documented. In response to the high interest from LCA practitioners those questions and problems were further explained and combined with potential solutions. The documentation was reviewed for relevance by internal and external experts and amended for missing aspects. An additional workshop with European experts and a public consultation with industry partners provided further feedback on applicability.

The final EeB Guidance document is accessible as a web-based interactive document with filter functions to facilitate its use. It also provides links to further detailed information sources, training materials and reporting templates

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Introduction

This deliverable reports the main recommendations for the building LCA tool developers. The report is divided in three parts: presentation of the main characteristics of exisiting building LCA tools, recommendations for applying EeBGuide provisions and guidance and a third part dedicated to the barriers and challenges for a new generation of building LCA tools.

1. Main characteristics of existing building LCA tools

Several building LCA tools already exist on the market. They have been developed since the 1990's along the development of the LCA methodology at ISO[1] (e.g. with the development of the ISO standards) or at SETAC[2]. Previous European projects funded by the seventh framework (e.g. PRESCO[3], ENSLIC-Building[4], LoRe-LCA[5]) have reported and described the existing LCA tools in Europe.

Table 1 presents the name of some of the existing building LCA tools, based on previous state of the art reports and additional information collected by the EeBGuide partners. In total, 12 LCA software have been identified in Europe (including Switzerland). No general LCA software such as SimaPro or GaBi were considered here as the recommendations of EeBGuide are mainly focusing on building LCA tools. We also do not take into account other international building LCA tools such as the Impact Estimator[6] or the BEES[7] software developed in North America as the recommendations are given within the European context for sustainable construction[8].

A template has been defined in this project to report the main updated characteristics of existing building LCA tools. It includes:

- Short description of the tool
- Country of development
- Type of software *[can it be used online or does the user need to install it on a personal computer?]*
- Website
- Purpose of the tool *[are there different data or calculation rules within the tools e.g. for early design or more advanced assessment?]*
- Modelling choices *[what are the modelling choices e.g. situation A, B or C according tot he ILCD Handbook?]*
- Study type *[are there different data or calculation rules within the tools e.g. for early design, use of a screening/simplified LCA while for more advanced assessment, use of complete LCA[9]?]*
- Data used *[which LCA data are used in the tool e.g. generic data, EPD…]*
- Life cycle stages assessed *[which building stages are included in the tool?]*

[1] ISO : International Standardization Organisation
[2] SETAC : Society of Environmental Toxicology and Chemistry
[3] www.etn-presco.net/
[4] http://circe.cps.unizar.es/enslic/index.htm
[5] www.sintef.no/Projectweb/LoRe-LCA/Training/
[6] Software developed by the Athena Institute (Canada) : http://calculatelca.com/software/impact-estimator/
[7] Software developed by the NIST (USA) : www.nist.gov/el/economics/BEESSoftware.cfm/
[8] However, some important aspects developed in EeBGuide could well be implemented in other international building LCA tools.
[9] Definition of screening, simplified and complete LCA according to EeBGuide propositions.

- Contributors assessed *[which contributors of the building total impacts can be assessed with the tool?]*
- Environmental indicators *[which indicators are taken into account?]*

Table 1: Presentation of the European building LCA tools considered in this review

Country	LCA tool for buildings	Developer
AUSTRIA	ECOSOFT	IBO[10]
FINLAND	BeCOST	VTT[11]
FRANCE	ELODIE	CSTB[12]
	EQUER	ARMINES / IZUBA Energies
GERMANY	GaBi Build IT	PE International
	SBS	Fraunhofer IBP / PE International
	LEGEP	WEKA
SWEDEN	ECOEFFECT	KTH / Univ of Gävle
SWITZERLAND	ECO-BAU	HEIG VD / LESBAT
THE NETHERLANDS	ECO-QUANTUM	IVAM
	GREENCALC+	Dutch Green Building Council
UNITED KINGDOM	IMPACT (replacing ENVEST II)	BRE

Tables 2 to 13 in appendix presents the review of the main characteristics of the existing LCA tools including the tools developed by EeBGuide partners (e.g. SBS, ELODIE, GaBi Build-IT and IMPACT).

Generally speaking, the review of the main characteristics of the existing LCA tools show that every LCA tool is developed with ist own goal and scope as shown by the database used e.g. generic data or industry specific data (like Environmental Product Declaration). They can be developed to fulfil early design assessments or more advanced assessment (including

[10] IBO : Österreichisches Institut für Baubiologie und Bauökologie
[11] VTT : Österreichisches Institut für Baubiologie und Bauökologie
[12] CSTB : Centre Scientifique et Technique du Bâtiment (French Scientific and Technical Centre for Building)

certification). Some tools offer the choice of the database. For example, LEGEP, developed in Germany, enables to choose between different databases.

Each building LCA tool has ist own datasets (that can be identical if taken from European database like Ecoinvent), ist own assumptions/calculation rules and ist own set of indicators. They assess different contributors such as the building products, the operational energy and water for the use phase etc.

There is currently no detailed breakdown according to the life cycle stages of EN 15804 / EN 15978 standards because these standards have just been published recently.

All the developed tools are currently only able to address the ILCD situation A (attributional studies). This can be explained by the fact that marginal and consequential datasets are currently missing.

The tools are also not harmonized in terms of life cycle stages some aggregating the results for the production, transport and construction stages while some breaking down such stages. Depending on the data types, some tools (e.g. the French LCA tool ELODIE) currently report the aggregated results for the impact of building products from cradle to grave[13].

Conclusion of the review:

The detailed characteristics of each tool presented in appendix show that each LCA tool has been developed under a specific context and with a pre-defined goal definition. This is a key aspect to mention when looking at EeBGuide provisions and guidance. Indeed, each building LCA tool currently lack in assessing the full „picture" of the building life cycle[14] for different study types and objectives.

To partly comply with the EeBGuide recommendations, it would lead us to actually pick up some of the current practices of the building LCA tools (e.g. generic data for screening LCA, EPD for more detailed assessment etc.).

The next chapter is now dedicated to give recommendations for building LCA tool developer to account for the EeBGuide provisions and guidance.

[13] The French Product Category Rules (NF P01-010 standard) does not require to breakdown the EPD indicators though the system boundaries are compulsory defined from cradle to grave (production, transport, construction, use, end of life)

[14] For example, few tools take into account the construction phase in an accurate way, most of them accounting only for cutting waste and do not consider the impact of the construction of the building.

2. Recommendations for implementing EeBGuide provisions and guidance in existing building LCA tools

With more than 100 importants aspects identified, the EeBGuide infohub (available online) is the latest updated source of information for building LCA tool developers. Beyond the content of each aspect (in terms of provisions, rules from both ILCD Handbook and CEN/ TC 350 standards, guidance), the EeBGuide provides a very systematic approach for carrying out building LCA studies.

The list below is a brief list of important aspects that would need to be included in LCA tools according to the EeBGuide:

- Development of filter functions to adapt or refine the goal and scope
- Inclusion of the different contributors of a building
- Implementation of the three study types
- Standardization of the reporting templates

These aspects as well as other taken from the guidance document are summarized below.

2.1. General aspects

- **Development of the three study types**

The implementation of the different study types aims at adapting and predefining:

- the data (and dataquality requirements),
- the calculation rules for each contributor and life cycle stage,
- the expression of results,
- the interpretation stage etc.

The next figure represents the different study types that can be implemented in an improved version of existing LCA tools for buildings. The definition of the study types depends on the building stakeholders and the project stages. For example, the screening LCA is recommended for an architect/design office during the early design stages of his project.

Recommendations for building LCA tool designers

In an improved version of a building LCA tool, different types of data, calculation rules should be implemented to fulfill the different needs of building stakeholders and the level of details of the project stages.
More information on the definition of the EeBGuide study types by clicking on the hyperlink: screening LCA, simplified LCA and complete LCA.

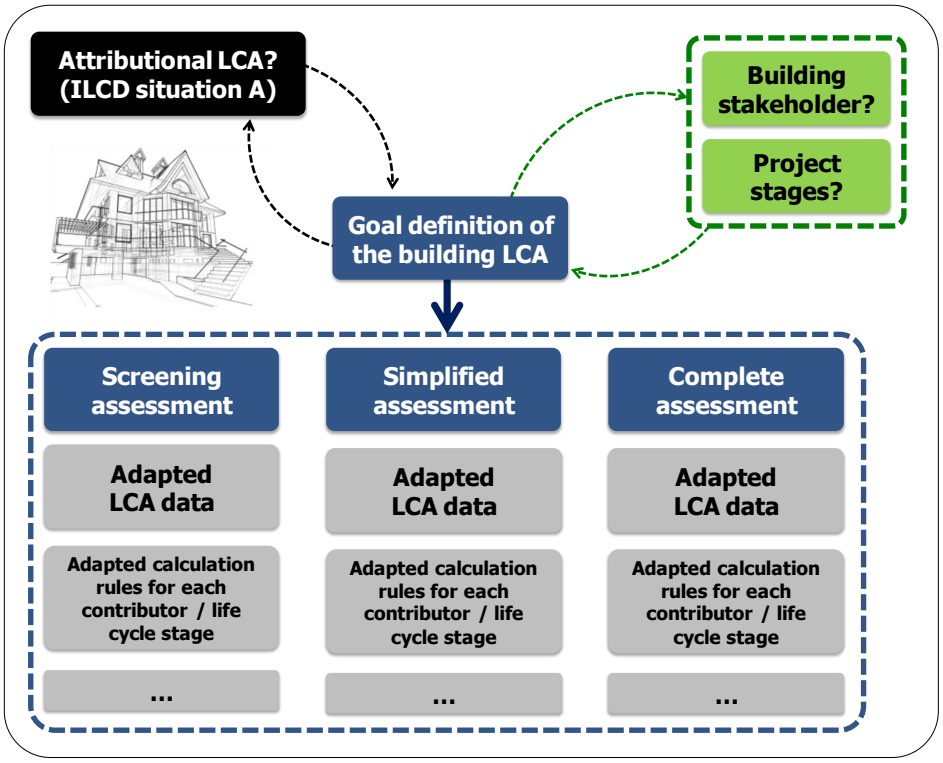

Figure 1: Representation of the three EeBGuide study types and their links to the modeling perspectives, project stages and building stakeholders

- **Development of filter functions to adapt or refine the goal and scope**

Aspects like the adaptation of the tool to answer different goal definition (the „flexibility" perspective) is an important requirement. However, this aspect may be difficult to reach due to substantial IT development e.g. if implementing a proper consequential approach. A solution may be to streamline for a specific goal definition the data and calculation rules.
For example, two examples can be mentioned among others:

- assessment of different refurbishment scenarios
- assessment of the evolution of the electric mix.

For instance, a methodology to account for different refurbishment scenarios is proposed in the guidance document (see aspect G-11). When implemented in a tool, the different steps of the scope definition can be predefined for the final user e.g. by breaking down the different refurbishment stages for each scenario.

In a first approach, consequential studies may also require light adjustments e.g. provide the users with different datasets (average and marginal consumption mix). In that case, the tool mainly rely on attributional approach with marginal datasets for scenario analyses[15]. Such

[15] See the aspect G-02 « Classifying the decision context as situation A, B, and C for building and product LCA » and aspect G-39 « Scenario analysis »

developments enable to improve the scope of the tools while keeping them as far as possible as user-friendly for the construction stakeholders.

- **Integration of other aspects according to the steps of the LCA framework**

Other specific aspects documented in the guidance document can be used as a basis by tool developers. Figure 1 presents the steps of the LCA framework. It can be noted the merging of both inventory analysis and impact assessment stages. This is due to the fact that most building LCA studies are done using already predefined data in terms of LCI or indicators (e.g. generic data or EPD of building products and processes). This is a simplification needed to keep building LCA tools (in opposite to general LCA software like SimaPro) as user friendly as possible for the practitioners that are not LCA experts.

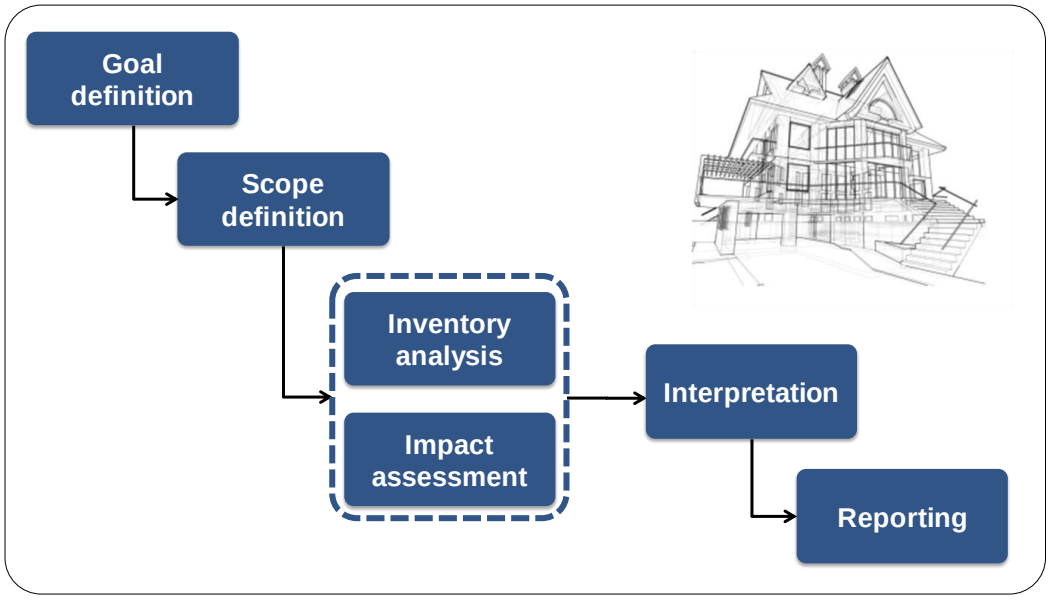

Figure 2: Representation of the different steps of the LCA framework

The full list of important general aspects to take into account in building LCA are reported in the online InfoHub for each step of the LCA framework. Some of these aspects are mentionned below with links to the relevant provisions and guidance.

Goal definition stage

- **Enables different goal definition** (see aspect G-01 „Goal definition for building and product LCA")
- **Assess design for recycling building alternatives** (see aspect D-01 „Inclusion of reuse, recovery or recycling potentials (Module D) in building or product LCA")
- For further aspects of the goal definition, please consult the InfoHub.

Scope definition stage

- **include fields for the documentation of the functional equivalent** of the building (see aspect G-06 „Functional equivalent")
- **enable LCA of existing buildings** by providing adequate data and calculation rules (see aspect G-11 „Definition of system boundaries for existing buildings")
- For further aspects of the scope definition, please consult the InfoHub.

Inventory and impact assesment stages

- **choose appropriate data for building products** and components (see aspects G-23/G-24/G-25 „Choice of LCI/LCIA datasets" for screening LCA, simplified LCA or complete LCA)
- **choose appropriate data and calculation rules for the contributor „operational energy use" for new buildings** (see aspects B-17/B-18/B-19 „Operational energy demand for new buildings – Boundaries and scenarios" for screening LCA, simplified LCA or complete LCA)
- **choose appropriate data and calculation rules for the contributor „operational water use"** (see aspects B-25/B-26/B-27 „Assessment of operational water use" for screening LCA, simplified LCA or complete LCA)
- **include data quality assesment** for LCA data (e.g. on building products, processes) and LCA results within the building LCA tool (see aspect G-22 „Data quality")
- For further aspects of the inventory and impact assessment stage, please consult the InfoHub.

Interpretation stage

- **use of normalisation factors** e.g. mean impacts for a reference buildings and normalisation factors in equivalents inhabitants per year (see aspect G-35 „Normalisation of indicators")
- **develop functions to select a consistent number of indicators** depending on the goal of the user e.g. either by defining a consistent set of indicators within the tool or by letting the user the possibility to display the results according to his preferences e.g. GWP, waste, water consumption, toxicity (see aspect G-28 „Choice of indicators for screening and simplified LCA" or G-29 for complete LCA)
- **enable sensitivity analyses** on the key parameters (see aspect G-38 „Sensitivity analysis")
- **enable uncertainty analyses for comparative assertions** of buildings (see aspect G-37 „Uncertainty analysis for comparative assertion")
- For further aspects of the interpretation stage, please consult the InfoHub.

Reporting stage

- **standardize the reporting templates**

A key aspect in spreading the use of LCA in the construction sector is to prefine within the building LCA tools a template for the methodological report and results as the main assumptions are prefined e.g. data types, calculation rules etc.
This aspect is described in more details in the guidance document (see aspect G-40 „Documentation of LCA results"). Examples of reporting templates are also freely available in sections Case studies or Downloads from the website.

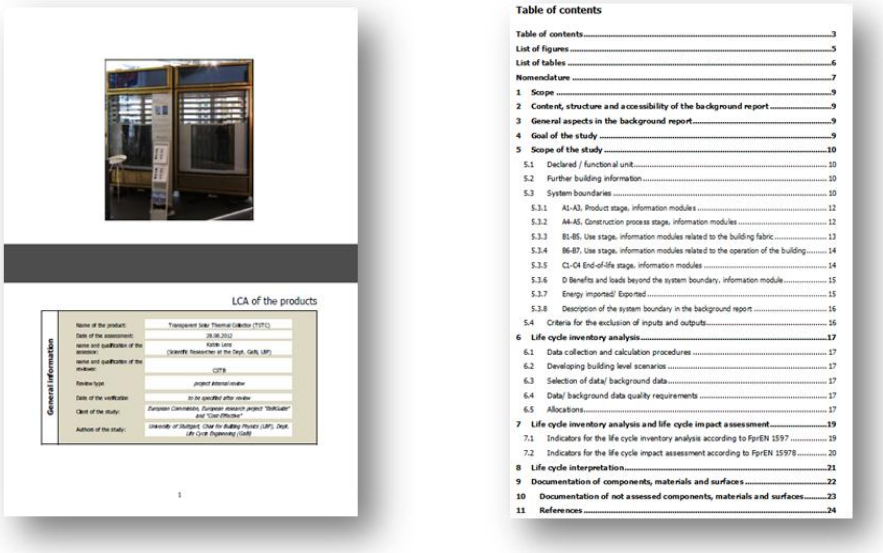

Figure 3: Visualisation of the first two pages of the EeBGuide reporting templates

- For further aspects of the reporting stage, please consult the InfoHub.

Recommendations for building LCA tool designers

In an improved version of a building LCA tool, standardized reporting templates should be provided to the user. They may be adapted depending on the context according to the chosen study types (screening, simplified or complete LCA).

2.2. Aspects for modules A, B, C and D according to the EN 15978 standard

- **Implementation of the conventional life cycle stages of a building**

Most of the existing building LCA tools do not have the same system boundaries. They also do not present and separate the results in a harmonized way. One of the major outcomes of EeBGuide is to propose harmonization of the life cycle stages. Figure 4 presents the name of the module according to the EN 15978 standard.

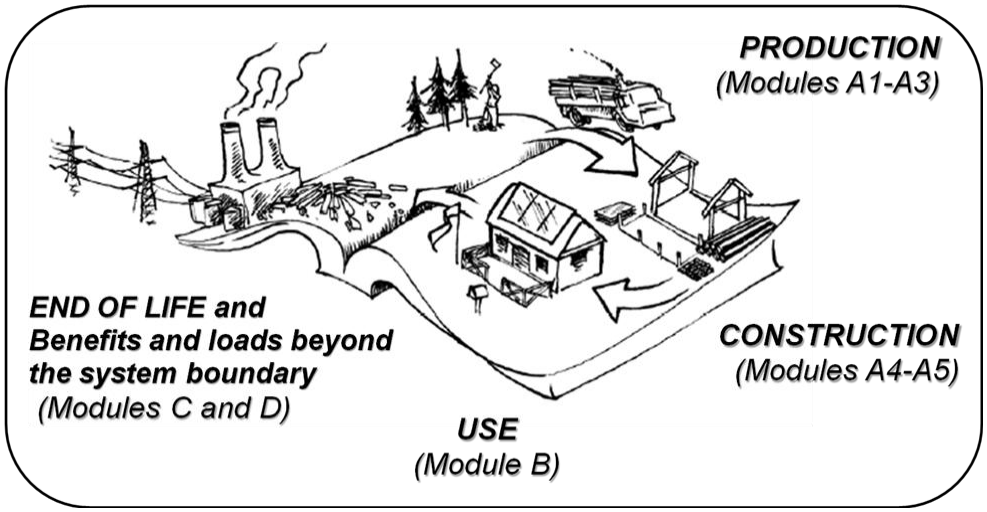

Figure 4: Life cycle stages of a building according to the European standard EN 15978

- **Inclusion of the different contributors of a building**

A building LCA can be breakdown in different impact sources. It is important to mention that each contributor needs adapted calculation rules and data. The only contributor that is defined all along the life cycle of a building is the „building products and technical equipment". For the others, they correspond to a particular life cycle stage e.g. the operational energy use corresponds to the module B6 according to the EN 15978 standard.

Such a distinction with the contributors is essential as it enables for the building practitioners to quickly identified the issue. Building stakeholders are more familiar with the notion of „contributor" than the life cycle stages as defined in EN 15804. The next figure presents an example of possible contributors that should be included in an improved building LCA tools[16].

[16] It can be noted that some tools already include most of these contributors (e.g. EQUER or ELODIE for the French context, with the exception of the construction site contributor to date)

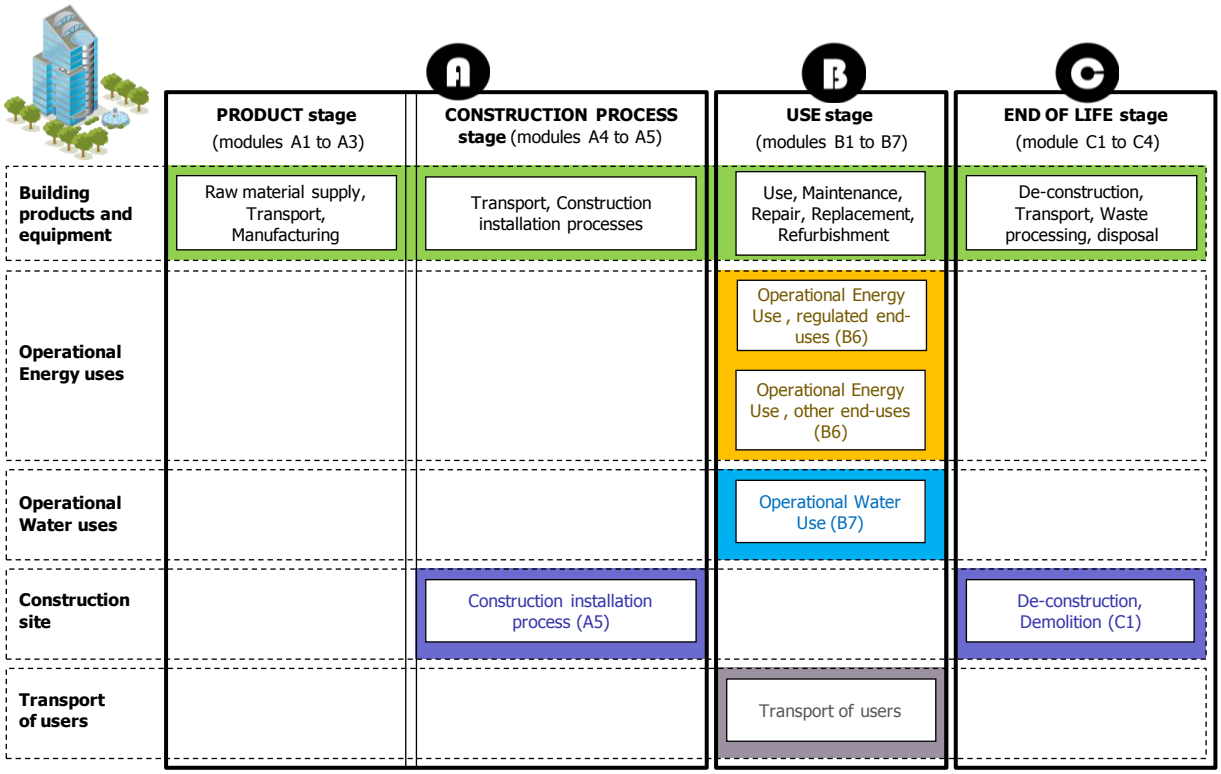

Figure 5: Examples of contributors that can be taken into account in building LCA tools

Recommendations for building LCA tool designers

In an improved version of a building LCA tool, the results should be breakdown according to both the conventional life cycle stages according to EN 15804 / EN 15978 but also according to the different contributors.

The full list of important aspects to take into account in building LCA are reported in the online InfoHub for each life cycle stages (modules A, B, C and D according to EN 15978). Some of these aspects are mentionned below with links to the relevant provisions and guidance.

PRODUCTION (Modules A1-A3)

- **Enables different data type** in the tool (see aspect A-01 „Use and adaptation of available cradle-to-gate and cradle-to-grave LCA or EPD data for building products and technical equipment")
- For further aspects concerning modules A1-A3, please consult the InfoHub.

CONSTRUCTION (Modules A4-A5)

- **Develop adapted scenarios for estimating the transport impacts** to the building site (see aspects A-04/A-05 „Transport of products to the construction site" for screening and simplified LCA or complete LCA)
- **Develop adapted data and calculation rules for the building site assessment** (see aspects from A-06 to A-23 in EeBGuide, Part B: BUILDINGS)
- For further aspects concerning modules A4-A5, please consult the InfoHub.

USE (Modules B1-B7)

- **Develop appropriate scenarios[17] for maintenance, repair, replacement and refurbishment** (see for example[18] aspect B-31 „Distinction between modules B2, B3, B4, B5)
- **Develop adapted calculation rules for the contributor „operational energy use" for new buildings** (see aspects B-17/B-18/B-19 „Operational energy demand for new buildings – Boundaries and scenarios" for screening LCA, simplified LCA or complete LCA)
- **Develop adapted calculation rules for the contributor „operational water use"** (see aspects B-25/B-26/B-27 „Assessment of operational water use" for screening LCA, simplified LCA or complete LCA)
- **Develop adapted calculation rules for the contributor „transport of the users"** (see aspect B-30 „Transport of the users of the buildings")
- For further aspects for module B, please consult the InfoHub.

END OF LIFE (Module C1-C4)

- **Develop adapted data and calculation rules for the deconstruction phase** (see aspects C-01/C-02 „Demolition/deconstruction" for screening and simplified LCA and complete LCA)
- **Develop adapted data and calculation rules for the building end of life** (see aspects for sub-modules transport, waste processing and disposal in EeBGuide, Part B: BUILDINGS)
- For further aspects concerning module C, please consult the InfoHub.

[17] Scenarios to be either prefined by the tool developer or let « open » for the advanced user.
[18] Several aspects are documented on hte InfoHub to provide guidance for developing scenarios for maintenance, repair, replacement and refurbishment

Benefits and loads beyond the system boundaries[19] (Module D)

- **Inclusion of recycling potentials in the tool** (see aspect D-01 „Inclusion of reuse, recovery or recycling potentials (Module D) in building or product LCA")
- For further aspects concerning module D, please consult the InfoHub.

[19] Reuse, recovery and recycling potentials

3. Barriers and challenges for a new generation of building LCA tools

The implementation of EeBGuide provisions and guidance is a very challenging topic as we can see from the description of the main characteristics of existing LCA tools than none of them include all the EeBGuide recommendations to date. The EeBGuide recommendations aim at increasing the use of the LCA in the building sector by proposing consistent guidelines according to different goal definitions and needs of the practitioners (that are not LCA experts).

However, the implementation of the provisions and guidance can only be done in partnership with the european and national LCA networks (e.g. industry, research, tool developers, data providers) involved in LCA applied to the construction sector. For example, every national context does not have ist own generic or EPD database to date which can be a limit for the proper implementation of EeBGuide study types (e.g. for screening and complete LCA). A temporary situation is to rely on existing data even if they are less appropriate for a national context[20].

Collaborative work is also needed between the different software developer e.g. between thermal analysis software and building LCA software to make sure the output of one tool fulfill the needs oft he other.
For example, if the user wants to assess the exported produced on site renewable energy[21] (allocation rules to be defined in the tool), the energy consumption values from the thermal analysis software need to be presented per hour and per end use (e.g. heating, domestic hot water...).

The proper implementation of CEN/ TC 350 standards also require feedbacks from the data providers to be sure the parameters used in the EN 15804 / EN 15978 standards are actually easy to get from the background data. For example, EN 15978 standard requests next to the LCIA indicators, some "reminder flows" (according to the ILCD terminology) named as "indicators describing resources use" (according to CEN terminology e.g. „Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials" or „Use of renewable secondary fuels") though major background databases (e.g. Ecoinvent, GaBi, ELCD) do not easily calculate them to date due to current LCI databases structures

Some specific aspects mentionned in EeBGuide e.g. the assessment of the construction site or the deconstruction activities also need a close cooperation with companies to get statistics and real data as input for the LCA tool. Without such a collaborative network, it will be difficult for a building LCA tool developer to progress on the assessment of these contributors.

[20] Such guidance is for example part of the InfoHub for the aspects N° G-23, G-24, G25 Choice of datasets for screening, simplified and complete LCA
[21] See e.g. aspect B-23 « Operational energy calculation – Allocation of energy production for on-site systems connected to grid »

Even if the modular structure of EeBGuide recommendations is very important to take into account to answer the needs of different practitioners and different project stages (in terms of life cycle stages, contributors and study type e.g. screening, simplified and complete), the tool should remain as user-friendly as possible to attract more building stakeholder using and carrying out building LCA.
One possible option is to ask once the user open the tool what is his goal definition and the stage of the project so that the adapted data, method, intepretation tools can be filtered. This is a very challenging aspect for the next generation of building LCA tools.

Conclusions

If the LCA approach should be applied in a multitude of research projects, but also in building labeling schemes and EPD schemes, LCA practitioners need on the one hand side provision and guidance, on the other hand support by reliable and easy to use LCA tools.

As an outcome of the EeBGuide project and especially the conduction of case studies on improved building LCA tools, the following requirements were found:

- Integration of the in EeBGuide defined study types (screening, simplified and complete).
- Structuring the results according to the life cycle stages of EN 15804 and EN 15978 standards
- Breakdown per contributor the results and the calculation rules
- Default values should be given for early design stages and life cycle stages beyond the focus of the study
- Possibility to directly create the EeBGuide reporting templates as an output of the software
- Possibility to perform sensitivity analysis and uncertainty analysis (Monte Carlo, etc.)
- Include the datasets from the ILCD database and also the specific documentation
- Link to CAD software, energy calculation software, etc. to optimize the workflow and to avoid transmission errors

A very important aspect will remain in a near future the documentation of the used datasets and the possibility to create automatically a list of all used datasets with the main important information (e.g. year of creation, used methodology, expire date, included lifecycle stages).

Finally it is important to have a core set of data, rules and indicators that ca be harmonised within the building LCA tools to make comparable building LCA results. However, some of the outcomes of the EeBGuide project also show the need of flexibility in building LCA studies to let the developer adapt his tool for different goal definition (next to a core set of harmonised data, methods and indicators e.g. for comparability purposes).

Literature

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Appendix

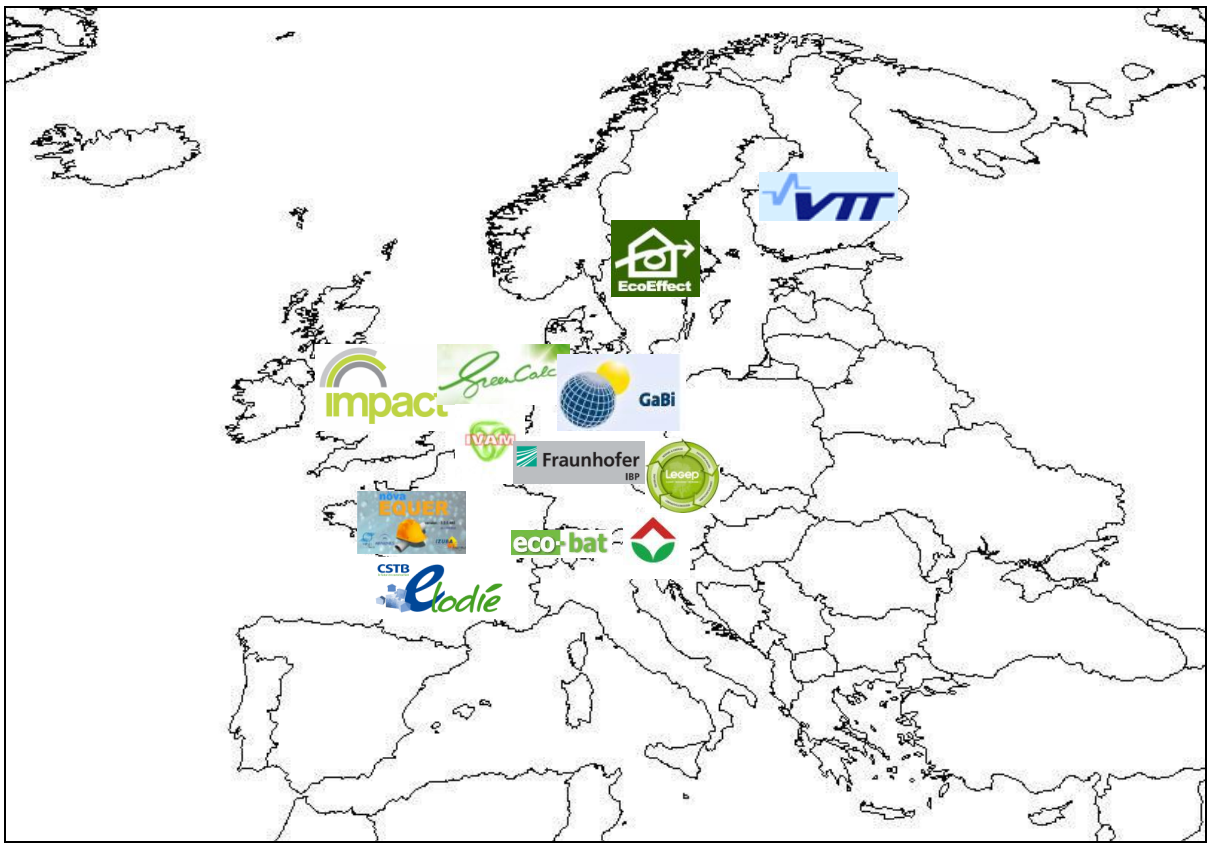

Figure 6: Logo of the existing European LCA tools (or developers) included in the appendix

Table 2: Description of the building LCA tool „ECOSOFT"

ECOSOFT	Details
Short description	ECOSOFT is a software for the ecological assessment of building components and buildings. It was developed by the IBO and is based on the MS Office application EXCEL. It does not include links to CAD systems neither to Life Cycle Cost assessment.
Country of development	Austria
Type of software	To install on individual computer, a demo version can be downloaded from the website
Website	www.ecoeffect.se
Purpose of the tool	To assess the environmental performance of buildings. The tool is oriented for professionals, such as architects and building engineers working in private and public sectors but also for educational purposes. The tool allows them to calculate the building service systems (optional), the refurbishments of buildings (OI3, optional).
Modeling choices	Situation A according to the ILCD Handbook (attributional LCA)
Study type	One type of assessment
LCA data used	IBO guide values database: which comprises more than 500 building materials (import of other data bases is possible). The database also includes data for transport and energy processes.
Life cycle stages assessed	Separation of life cycle phases according to Austrian norms *No detailed breakdown according to the life cycle stages of EN 15804 / EN 15978 standards.*
Contributors assessed	• Building materials and products • Operational energy use (end uses according to the EPBD)
Environmental indicators	7 indicators considered in the tool: ○ Global Warming Potential (GWP) ○ Acidification potential (AP) ○ Primary Energy Content, renewable and non-renewable (PEI e, PEI ne) ○ Production of photooxidants (POCP) ○ Eutrophication (EP) ○ Eco-index OI3 BGF, OI3 BZF, OI3 lc ○ Disposal indicator EI

Table 3: Description of the building LCA tool „BeCOST"

BeCost	Details
Short description	BeCost is a tool for life cycle assessment of building structures and for the whole building. The program includes: - the environmental profiles, costs and maintenance costs of building materials produced in Finland, - the structures for designing outdoor walls, indoor walls, roofs, floors, etc. - Material quantity calculations - Environmental profile calculation for designed structure - Result as plot of environmental profile (emissions), energy- and raw-material use, and cost impact for the structure and whole building. BeCost is an easy to use program - the user should first define the building by making relevant choices, by choosing the structure and materials, by giving the volumes in m2 and by choosing the service life of the building.
Country of development	Finland
Type of software	Web-based tool
Website	http://virtual.vtt.fi/virtual/proj6/environ/ohjelmat_e.html
Purpose of the tool	This can be used for different purposes: • to examine the ecological effect of building choices related to materials used and service life of the whole building (designer and constructors use); • verifying environmental characteristics' fulfillment, if such has been demanded (designer use); • for owners to examine their building's environmental profiles (owner use); • checking the affect of care, maintenance and repairing actions on the environment; • comparing environmental profiles of structures having the same functional units; and • comparing environmental impacts of produced- and competing materials in certain structure or building (use of building material producer).
Modeling choices	Situation A according to the ILCD Handbook (attributional LCA)

BeCost	**Details**
Study type	Only one study type, with predefined data for assessing trasnport to the building type, and maintenance sceanrio during the use phase[22]
LCA data used	Environmental profiles of building materials produced in Finland by means of RT Environmental Declaration (only cradle to gate declaration)
Life cycle stages assessed	Production, transport, use (incl. maintenance). The End of life is not taken into account in the tool. *No detailed breakdown according to the life cycle stages of EN 15804 / EN 15978 standards.*
Contributors assessed	• Building materials and products • Operational energy use
Environmental indicators	No environmental indicators considered in the tool, only inventory flows such as: ○ CO_2, CO, CH_4, N_2O, $S0_2$, NO_x, NH_3, VOC…
Interpretation of the results	No methods implemented in the tool

[22] Personnal communication with Sirje Vares (11-12-2012)

Table 4: Description of the building LCA tool „ELODIE"

ELODIE	**Details**
Short description	ELODIE is a building LCA software calculating the environmental impacts due to construction materials and products, the operational energy and water use (in line with NF P01-010, NF P01-020-1 and XP P01-020-3 French standards), construction site processes and the transport of users. To calculate the construction products contribution ELODIE uses Environmental Product Declarations (EPD) provided by manufacturers and made available through the INIES (www.inies.fr) database. As a result, ELODIE provides an environmental multicriteria profile of the building and will provide in 2011 a overall score of the building that will enable an easier environmental comparison of buildings. It also provides tools to help designers to identify major environmental improvement solution. It will soon integrate a link to a Building Information Model (BIM).
Country of development	France
Type of software	Web based tool, a demo version can be downloaded from the website
Website	www.elodie-cstb.fr
Purpose of the tool	Detailed assessment of the environmental impacts of buildings
Modeling choices	Situation A according to the ILCD Handbook (attributional LCA)
Study type	Possibility for the user to select 2 study types for each contributor: - Simplified assessment* - Complete assessment*
LCA data used	Based on the French EPD of building products (called in French „FDES") and technical equipment (called in French „PEP") as well as generic data (adapted from french industry average or generic european data)
Life cycle stages assessed	Production, Transport, Construction, Use (incl. remplacement of products), End of life *In 2012, no breakdown according to the life cycle stages of EN 15804 / EN 15978 standards*
Contributors assessed	• Building products and technical equipment • Operational energy use (end uses according to the French thermal regulation) and operational energy use (other uses)

ELODIE	Details
	• Operational water use • Transport of the users of the building • Waste generated during the use/activity of the building
Environmental indicators	15 indicators considered in the tool based on CML, 2001 (Guinée, 2001) and on the French standard NF P01-010 (PCR for EPD of building products): ○ Total primary energy [in MJ] ○ Process primary energy (or « fuel ») [in MJ] ○ Primary energy, non renewable [in MJ] ○ Primary energy, renewable [in MJ] ○ Abiotic resource depletion (ADP) [in kg eq-Sb] ○ Water consumption [in L] ○ Hazardous, non hazardous, inert waste [in kg] ○ Radioactive waste [in kg] ○ Global warming potential, 100 years (GWP) [in kg eq-CO2] ○ Acidification potential (AP) [in kg eq-SO2] ○ Air pollution [in m3 of polluted air] ○ Water pollution [in m3 of polluted water] ○ Ozone depletion potential (ODP) [in kg eq-CFC-11] ○ Photochemical ozone creation (POCP) [in kg eq-C_2H_4] ○ Eutrophication (EP) [in kg eq-$PO_4^{(3-)}$] Additional indicators are under implementation (e.g. from EN 15978 standard)
Interpretation of the results	Normalisation values (benchmarks) concerning reference buildings representing average practice. They enable the user to compare his design alternatives.

** The definition of simplified and complete assessment in the current version of ELODIE is not fully compliant with EeBGuide provisions and guidance.*

Table 5: Description of the building LCA tool „EQUER"

EQUER	Details 
Short description	EQUER performs simulations of a building's life cycle, in order to provide designers with environmental indicators, allowing a project to be assessed from an environmental perspective (e.g. global warming, acidification and eutrophication potentials, exhaust of natural resources,…).
Country of development	France
Type of software	To install on individual computer, a demo version can be downloaded from the website
Website	www.izuba.fr/logiciel/equer
Purpose of the tool	Tool for ecodesign of buildings (the LCA needs to be done after a thermal analysis) that can be used by different building practitioners e.g. mechanical, energy, and architectural engineers working for architect/engineer firms, architects, consulting firms, utilities, federal agencies, urban designers, universities, and research laboratories. EQUER is linked to the energy simulation tool COMFIE. The tool requires input from the user about the building geometry, material characteristics, internal loads and schedules, climate, heating and cooling equipment characteristics. Water consumption, waste generation and transport issues may be taken into account, depending on the goal of the study. Readable, structured input file is generated by the PLEIADES (thermal simulation) and ALCYONE (2-3D modeller) user interface.
Modeling choices	Situation A according to the ILCD Handbook (attributional LCA)
Study type	The software does not show different study types. It is possible to use default values or more specific values for sensitivity analyses on some parameters (e.g. transport to the building site, material losses on site, service life of components, end-of-life parameters e.g. distances to landfill, incineration and recycling facilities).
LCA data used	Based on the different versions of the ecoinvent database regularly updated in the software (version 1.0, 1.3, 2.0, 2.2) if the user has bought an ecoinvent licence. A contextualisation method for building materials is proposed mainly by changing the grid mix from Swiss or Europe to France. EQUER uses only some LCIA data of the full ecoinvent database. These data corresponds to some building materials, products and other processes for energy, transport, waste management and end-

EQUER	**Details** 
	of-life.
Life cycle stages assessed	Production, Construction (only the material losses), Use, Refurbishment, End of life. *No detailed breakdown according to the life cycle stages of EN 15804 / EN 15978 standards though the results are presented for the construction phase (module A of EN 15978), the use and refurbishment phases (module B of EN 15978) and end of life (module C of EN 15978).* *Allocation rules for recycling materials based on avoided burden (50/50) between production and end of life stage. As a result, the module D (according to EN 15978) is here allocated to both production and end of life stage within the LCA results.*
Contributors assessed	• Building products • Operational energy use (end uses according to the French thermal regulation) and operational energy use (other uses), energy consumption data directly linked to a dynamic thermal simulation software (COMFIE) • Operational water use • Transport of the users of the building • Waste generated during the use/activity of the building
Environmental indicators	12 indicators considered in the tool based on CML, 2001 (Guinée et al, 2001) and Ecoindicator 99 (Goedkoop and Spriesma, 2000) : ○ Global warming potential, 100 years (GWP) [in kg eq-CO_2] ○ Acidification potential (AP) [in kg eq-SO_2] ○ Eutrophication potential (EP) [in kg eq-$PO_4^{(3-)}$] ○ Abiotic Resources Depletion (ADP) [in kq eq-Sb] ○ Damages to human health by means of Disability Adjusted Life Loss Years [in DALY] ○ Damages to ecosystems by means of Potentially Disappeared Fraction of species [in PDF*m^2/year] ○ Photochemical Ozone creation potential (POCP) [in kg eq-C_2H_4] ○ Odours [in m^3 of polluted air] ○ Total Primary Energy Demand (excluding solar renewable resources) [in MJ] ○ Water consumption [in m^3] ○ Radioactive waste [in dm^3] ○ Other waste production [in tons equivalent of inert wastes]
Interpretation of the results	Normalisation factors concerning the average impacts in equivalent year inhabitants. The values are provided for the indicators where normalisation factors exist for the French context.

Table 6: Description of the building LCA tool „GaBi Build-IT"

GaBi Build-IT	**Details**
Short description	GaBi Build-it (available in German only) is the professional software solution for conducting the Life Cycle Assessment (LCA) of buildings. GaBi Build-it can be used to analyse the environmental performance of different design scenarios or individual building elements. Users simply enter the amount of building materials and the energy demand of the building and GaBi Build-it calculates the environmental impact of the building in line with the ISO 14040/14044 Life Cycle Assessment methodology and the requirements of the DGNB. The contribution, to these environmental impacts, from each of the material groups and building elements is transparently displayed, showing the breakdowns of impacts according to materials group (according to DIN276-1) and to life cycle stage.
Country of development	Germany
Type of software	To install on individual computer
Website	www.pe-international.com/sweden/services-solutions/green-building/building-lca/
Purpose of the tool	GaBi Build-it is ideal for building certification since it is fully aligned with the calculation and documentation requirements of the DGNB and can be used on the following DGNB variants: • Office and administration buildings – "Neubau Büro- und Verwaltungsgebäude (NBV08) und (NBV09)" • Trade/commerce buildings – "Neubau Handelsbauten, Version 2009 (NHA09)" • Educational facilities – "Neubau Bildungsbauten, Version 2009 (NBI09)" • Industrial constructions – "Neubau Industriebauten, Version 2009 (NIN09)" • Redevelopments – "Komplettsanierung, Version 2010 (KBV10)" • Residential buildings – "Neubau Wohnungsbauten, Version 2010 (NWO10)"
Modeling choices	Situation A according to the ILCD Handbook (attributional LCA)
Study type	Possibility for the user to select a simplified assessment* due to its predefined generic building model

GaBi Build-IT	**Details**
LCA data used	Based on the building product databases Ökobau.dat The GaBi Build-it solution is based on a generic building model and includes the specific maintenance cycles of the building materials as well as their end of life treatment and disposal as defined in the DGNB certification scheme.
Life cycle stages assessed	Production, Use (incl. replacement of products), End of life *In 2012, no breakdown according to the life cycle stages of EN 15804 / EN 15978 standards*
Contributors assessed	• Building products
Environmental indicators	6 indicators considered in the tool : ○ Global warming potential (GWP) [in kg eq-CO2] ○ Acidification potential (AP) [in kg eq-SO2] ○ Eutrophication (EP) [in kg eq-$PO_4^{(3-)}$] ○ Ozone Depletion Potential (ODP) [in kg eq-CFC-11] ○ Photochemical Ozone creation potential (POCP) [in kg eq-C_2H_4] ○ Primary Energy Demand (from fossil and renewable sources) [in MJ]

** The definition of simplified and complete assessment in the current version of ELODIE is not fully compliant with EeBGuide provisions and guidance.*

Table 7: Description of the building LCA tool „SBS"

SBS	Details
Short description	The Sustainable Building Specifier (SBS) is a software tool for the efficient creation of building Life Cycle Assessments (LCA). SBS can be used on the one hand for the purpose of labeling under the rules of the German Sustainability Council and on the other hand for European research projects. Therefore it provides not only a German LCA database (Ökobau.dat), but also a European database (ESUCO).
Country of development	Germany
Type of software	Web based tool
Website	http://sbs-prod.elasticbeanstalk.com
Purpose of the tool	LCA for German DGNB certification and European research projects
Modeling choices	Situation A according to the ILCD Handbook (attributional LCA)
LCA data used	Based on the building product databases Ökobau.dat (generic German database and German EPD) and ESUCO (generic European database)
Life cycle stages assessed	Production, Use (incl. replacement of products), End of life *In 2012, no breakdown according to the life cycle stages of EN 15804 / EN 15978 standards*
Contributors assessed	• Building products • Operational energy use (end uses according to the EPBD)
Environmental indicators	13 indicators considered in the tool : ○ Primary energy, non renewable [in MJ] ○ Primary energy, renewable [in MJ] ○ Secondary fuels [in MJ] ○ Water consumption [in L] ○ Dressing residues and overburden [in kg] ○ Household rubbish and commercial waste [in kg] ○ Hazardous waste [in kg] ○ Abiotic resource depletion [in kg eq-Sb] ○ Global warming potential (GWP) [in kg eq-CO2] ○ Acidification potential (AP) [in kg eq-SO2] ○ Photochemical ozone creation (POCP) [in kg eq-C_2H_4] ○ Eutrophication (EP) [in kg eq-$PO_4^{(3-)}$] ○ Ozone depletion potential (ODP) [in kg eq-CFC-11]

Table 8: Description of the building LCA tool „LEGEP"

LEGEP	Details
Short description	LEGEP is an integral software for integral project design. It assesses Life Cycle Assessment (LCA), Life Cycle Cost (LCC) based on German standard DIN 276 (Kosten Plannung) and Operational Energy use assessment by means of 5 modules integrated in the tool: - LEGEP-Kostenplanung, - LEGEP-Lebenszykluskosten, - LEGEP-Ökobilanz, LEGEP-Wärme & Energie - LEGEP-Wirtschaftlichkeit.
Country of development	Germany
Type of software	To install on individual computer, a demo version can be downloaded from the website
Website	www.legep-software.de
Purpose of the tool	Integrated tool (with a LCA module) for building planners and designers. It can also be used for the German certification system (DGNB).
Modeling choices	Situation A according to the ILCD Handbook (attributional LCA)
Study type	One type of assessment, the main focus on LEGEP being put on the integrated assessment (LCA but also LCC). The user can however select different LCA databases for describing the materials. In LEGEP, the user can describe a building from different scale starting at the bottom with life cycle inventory of material layers and composed elements (e.g. windows) up to macro elements (e.g. a roof). The user can also define scenarios for maintenance, cleaing and refurbishment. The data are fully scaleable and can be used either "bottom-up" or "top-down".
LCA data used	Different databases can be used depending on the project stages and on the practitioners e.g. Ecoinvent data and specific values from the Baustoff Ökoinventare database (see the REGENER Project) and the LEGEP database with specific values for construction products. The LEGEP database contains the description of all elements of a building (based on DIN 276). All information is structured along life cycle phases (construction, maintenance e.g. replacement of products, operation such as cleaning), refurbishment and demolition.

LEGEP	**Details**
Life cycle stages assessed	All the building life cycle stages are covered in LEGEP including construction, use (e.g. health risks regarding indoor climate by means of product substances based on the documentation rules of REACH and EU regulations), maintenance, operation, refurbishment and demolition. *No detailed breakdown according to the life cycle stages of EN 15804 / EN 15978 standards though the results are presented for the construction phase (module A of EN 15978), the use and refurbishment phases (module B of EN 15978) and end of life / demolition (module C of EN 15978).*
Contributors assessed	• Building products • Operational energy use (energy demands for heating, hot domestic water, electricity according to the German standard EnEV 2007, DIN 18599 and EN 832) • Operational water use (based on statistics)
Environmental indicators	10 indicators considered in the tool (CML method): ○ Global warming potential, 100 years (GWP) [in kg eq-CO2] ○ Acidification potential (AP) [in kg eq-SO2] ○ Eutrophication potential (EP) [in kg eq-$PO_4^{(3-)}$] ○ Abiotic Resources Depletion (ADP) [in kq eq-Sb] ○ Photochemical Ozone creation potential (POCP) in kg eq-C_2H_4] ○ Total Primary Energy Demand [in MJ] ○ Primary Energy Demand, renewable and non renewable [in MJ] Additional indicators are under implementation (DALY etc.)
Interpretation of the results	Diagram (e.g. sankey diagrams), numerci and graphical results

Table 9: Description of the building LCA tool „ECOEFFECT"

ECOEFFECT	Details
Short description	The EcoEffect method has a holistic perspective of environmental issues with five parallel areas of focus: Energy, Material, Indoor Environment, Outdoor Environment and Life Cycle Costs. The method primarily target decision makers within the planning, designing and, management of the built environment. The EcoEffect software has been developed within the project, which together with a so-called Input Data Sheet constitutes a tool for using the EcoEffect method in practice.
Country of development	Sweden
Type of software	The software can be requested from the website
Website	www.ecoeffect.se
Purpose of the tool	The objective of the EcoEffect method is: 1) to quantitatively describe environmental and health impact from real estate and the built environment 2) to provide a basis for comparison and decision making that can lead to reduced environmental impact.
Modeling choices	Situation A according to the ILCD Handbook (attributional LCA)
Study type	In the EcoEffect method, a life cycle assessment methodology is used for calculation of environmental impacts from the use of energy and material in the real estates/buildings
LCA data used	Internal database Environmental data for different energy types, selected material groups, and reference values that are used in the calculations.
Life cycle stages assessed	Contains the whole chain of environmental impacts from raw material extraction to the use of waste products/ demolishing associated with the energy and material flows. The current version of EcoEffect does not include the following: building phase, waste generated and leaving the real estate, flow of water and wastewater, land use, location issues. *No detailed breakdown according to the life cycle stages of EN 15804 / EN 15978 standards.*
Contributors	• Building products

ECOEFFECT	Details
assessed	• Operational energy use
Environmental indicators	Environmental assessment area is carried out within each for a number of different impact categories e.g. climate change, acidification, noise, etc. 8 indicators considered in the tool (external impact): ○ Global warming potential ○ Stratospheric Ozone depletion ○ Acidification potential ○ Nutrification ○ Ground ozone formation ○ Human Toxicity ○ Ecotoxicity ○ Natural ozone depletion In addition, internal impact indicators describing potential problems for users of a building are included for indoor aspects (e.g. thermal comfort, sound condition etc.) as well as for outdoor aspects (air quality, ground pollution etc.)
Interpretation of the results	In order to present an aggregated result that simplifies comparisons, a weighting method has been developed within the project that is based on the assessment direct and indirect problems to human being associated with environmental impacts. Weights can be changed and used for sensitivity analysis.

Table 10: Description of the building LCA tool „Ecobau"

Eco-bat	Details
Short description	Tool for Life Cycle Assesment of buildings specially adapted for early design stages.
Country of development	Switzerland
Type of software	To install on individual computer, a demo version can be downloaded from the website
Website	www.eco-bat.ch
Purpose of the tool	Early design assessment of buildings oriented towards architects, design offices willing to quantify the environmental impacts of energy and materials use all along the life cycle of a building.
Modeling choices	Situation A according to the ILCD Handbook (attributional LCA)
Study type	Eco-bau provides three different products to perform the life cycle impacts analysis of a building: Eco-Bat 4.0 is an independant tool with which you can very quicky modelize a building and perform a detailed life cycle impacts assessment. The ECO module allows the user to evaluate the environmental impacts of a building modelized in Lesosai 6 (thermal analysis software). This free module is included in the latest version of Lesosai. It provides a basic display of the global results of the ecobalance. Another module (ECO+) provides more detailed results at elements and materials levels. From a LCA perspective, the user can either choose to model the transport to the building site phase or not. If is included in the system boundaries, he can choose either a default value for Switzerland or enter his own values per building products.
LCA data used	KBOB data based on Ecoinvent data
Life cycle stages assessed	All the building life cycle stages are covered including production, transport to the building site, use (with operational energy end uses), replacement and disposal (end of life). *No detailed breakdown according to the life cycle stages of EN 15804 / EN 15978 standards though the results are presented for the construction phase (module A of EN 15978), the use and refurbishment phases (module B of EN 15978) and end of life / demolition (module C of EN 15978).*
Contributors	• Building products (assessment of embodied energy according to

Eco-bat	Details
assessed	Minergie-ECO 2011 and SIA 2032 technical report). • Operational energy use (heating, domestic hot water, cooling, ventilation, lighting and electrical equipment)
Environmental indicators	6 indicators considered in the tool: ○ Non renewable energy (NRE) [in MJ] ○ Cumulative Energy Demand (CED [in MJ] ○ Global warming potential, 100 years (GWP) [in kg eq-CO2] ○ Acidification potential (AP) [in kg eq-SO2] ○ Photochemical Ozone creation potential (POCP) in kg eq-C_2H_4] ○ Umwelt Belastung Punkten (UBP) [in points] Additional indicators can be asked on demand.
Interpretation of the results	Graphical results at different scales : full building, construction elements and materials.

Table 11: Description of the building LCA tool „GreenCalc+"

GreenCalc+	Details
Short description	GreenCalc+ is a tool that enables the sustainability assessment of a building or a district by means of Life Cycle Assesment and Life Cycle Cost.
Country of development	The Netherlands
Type of software	To install on individual computer, a demo version can be downloaded from the website
Website	www.greencalc.com http://www.legep-software.de/
Purpose of the tool	GreenCalc+ can carry out LCA studies of buildings. It is one of tools suitable for the BREEAM-NL certification scheme for the calculation of the environmental impacts of materials.
Modeling choices	Situation A according to the ILCD Handbook (attributional LCA)
Study type	One type of assessment
LCA data used	Use of national Milieudatabase It is the result of a harmonisation of different milieudatabases, including the previously in GreenCalc+ database used. The purpose of the harmonisation is a calculation in GreenCalc+, GPR, Eco-Quantum , DuboCalc and Eco-Install gives the same end result: milieueffectscores and milieukengetallen.
Life cycle stages assessed	All the building life cycle stages for the building products. *No detailed breakdown according to the life cycle stages of EN 15804 / EN 15978 standards.*
Contributors assessed	• Building products (according to NEN 8006:2004) • Operational energy use (according to NEN 2916: 2004 en de NEN 5128:2004) • Operational water use (according to WPN "Water Prestatie Norm" NEN 6922) • Transport of users of the building (according to the software programme VPL-KISS)
Environmental indicators	17 indicators considered in the tool (the methods for the calculation of the indicators can be retrieved on the following online report : www.greencalc.com/monetarisering.pdf, GreenCalc+ mainly uses CML-2, Eco-indicator 99 method, the original TWIN-model (Hare, 1997) and the method of Müller-Wenk for the assessment of noise

GreenCalc+	Details
	pollution by road transport): Emissions indicators ○ Global warming potential, 100 years (GWP) [in kg eq-CO_2] ○ Ozone depletion potential (ODP) [in kg eq-CFC-11] ○ Human Toxicity [in kg eq-1.4DB] ○ Ecotoxicity, aquatic (water) [in kg eq-1.4DB] ○ Ecotoxicity, terrestrial [in kg eq-1.4DB] ○ Photochemical Ozone creation potential (POCP) in kg eq-C_2H_4] ○ Acidification potential (AP) [in kg eq-SO_2] ○ Eutrophication potential (EP) [in kg eq-$PO_4^{(3-)}$] Depletion indicators ○ Biotic Resources Depletion [in mbp] ○ Abiotic Resources Depletion, elements [in kq eq-Sb] ○ Abiotic Resources Depletion, fossil fuels [in kq eq-Sb] Land transformation indicator ○ Damages to ecosystem [in PDF*m^2/year] Nuisance indicators ○ Odour [in OTV m^3] ○ Noise due to road transport [in DALY] ○ Noise due to production process [in mbp] ○ Light [in mbp] ○ Disaster [in mbp]
Interpretation of the results	Aggregation of indicators by means of monetarisation values into a single score index. The list of the monetarisation values for can be found online : www.greencalc.com/monetarisering.pdf Calculation of an index for the environmental quality of the building (« MIG ») that compares the environmental impacts of the studied building (standard use based on scenarios) with a reference building. In the same approach, the tool calculate an index for the use of the building (« MIP ») that compares the environmental impacts of the studied building (current use and impacts) with a reference building.

Table 12: Description of the building LCA tool „ECO QUANTUM"

ECO-QUANTUM	**Details**
Short description	Eco-Quantum's VO Tool is life cycle assessment tool for buildings used during the provisional design phase.
Country of development	The Netherlands
Type of software	To install on individual computer, the software can be downloaded from the website
Website	www.ivam.uva.nl/index.php?id=559&L=1#c4126
Purpose of the tool	There are two client groups. Those who design and supply buildings i.e. the architects (to get an idea of the overall environmental impact of a building at an early stage in the design process) and those who commission them i.e. local authorities, developers and housing corporations (to set quantifiable performance criteria).
Modeling choices	Situation A (attributional)
Study type	First, a building type is selected. Then the materials to be used are specified, although in more general terms than required in Eco-Quantum. The results of this input are immediately displayed on the same screen, as basic environmental statistics. For more detailed information, you can submit your data to Eco-Quantum itself. The tool proposed predefined values for products and elements, including life cycle assessment from cradle to grave (already defined scenarios for transport, use and end of life).
LCA data used	Environmentally relevant product information (EPD: Environmental Product Declaration, or in Dutch: MRPI in accordance with Dutch standard NEN 8006) provided by the building industry and research
Life cycle stages assessed	All the building life cycle stages are covered including production, Construction (only the material losses), Use, End of life, (and recycling potentials). *No detailed breakdown according to the life cycle stages of EN 15804 / EN 15978 standards though the use of recycling potentials make it similar to the module D of EN 15978 „Benefits and loads beyond the system boundaries".*
Contributors assessed	• Building products (according to NEN 8006:2004) • Operational energy use (according to NEN 2916: 2004 en de NEN 5128:2004), data taken from energy performance calculation

ECO-QUANTUM	**Details** 
	• Operational water use
Environmental indicators	The program then calculates the building's environmental impact. As required, this can be presented either as basic statistics (raw materials, emissions, energy, and waste) or in the form of a comprehensive environmental profile. As well as seeing the final totals, the user can "zoom in" on each item to see what the greatest environmental threat is. Usual effect oriented indicators based on CML (mid-point categories) are considered in the tool[23]: ○ Depletion of resources ○ Greenhouse effect ○ Depletion of the ozone layer ○ Photochemical ozone oxidant ○ Human toxicity ○ Ecotoxicity (water, sedimental, terrestrial) ○ Acidification ○ Nutrification ○ Energy consumption ○ Waste ○ Dangerous waste

[23] Indicators retrieved from the PRESCO report available online : www.etn-presco.net

Table 13: Description of the building LCA tool „IMPACT"

IMPACT	Details
Short description	IMPACT is a specification and database for software developers to incorporate into their tools to enable consistent Life Cycle Assessment (LCA) and Life Cycle Costing (LCC). IMPACT allows construction professionals to measure the embodied environmental impact and life cycle cost performance of buildings. IMPACT is integrated into 3D CAD/BIM (Building Information Modelling) software tools. Phase 2 of the IMPACT project will introduce IFC (Industry Foundation Class) interoperability for reliable and efficient integration. The results generated by IMPACT can be used in whole building assessment schemes.
	IMPACT is based upon the former LCA software Envest II[24] developed in the past by BRE
Country of development	United Kingdom
Type of software	To incorporate in existing tools (more information on the website) IMPACT is not a single tool but is a Specification and dataset for developing IMPACT Compliant tools, whether installed on a user's PC or made available online. The first IMPACT Compliant tool is by Integrated Environmental Systems Ltd. within their VE building simulation suite and SketchUP plugin.
Website	www.impactwba.com
Purpose of the tool	Calculation of building-level embodied (life-cycle) environmental impacts and life-cycle costing.
Modeling choices	Situation A (attributional)
Study type	
LCA data used	IMPACT uses the BRE LCA dataset which is generated using the BRE Environmental Profiles Methodoloogy from primary data provided by UK Trade Associations, with supporting data from Ecoinvent.

Life cycle stages assessed	• EN 15978
	  ○ A1 to A3 (combined) (Product stage)
	  ○ A4 (Construction stage: Transport)

[24] This software is no longer developed [personal communication with the developers of the IMPACT tool]

IMPACT	Details
	○ A5 (Construction stage: Construction installation) ○ B1 (In use stage: Use) ○ B2 (In use stage: Maintenance) ○ B4 & B5 reported in B5 (In use stage: Refurbishment & Replacement) ○ B6 (In use stage: Operational energy) ○ B7 (In use stage: Operational water) ○ C4 (End of life stage: Disposal)
Contributors assessed	• Building products • Construction/installation • Operational energy use • Operational water use
Environmental indicators	13 indicators considered in the tool based on the BRE methodology : • According to BRE methodology ○ Global warming potential ○ Water Extraction ○ Mineral Resource Extraction ○ Depletion potential of the stratospheric ozone layer ○ Human Toxicity ○ Ecotoxicity to water ○ Nuclear Waste (higher level) ○ Ecotoxicity to Land ○ Waste Disposal ○ Fossil Fuel Depletion ○ Eutrophication potential ○ Formation potential of tropospheric ozone photochemical oxidants ○ Acidification potential of land and water sources Additional indicators from the EN 15978 standard are under implementation e.g. ○ Global warming potential ○ Depletion potential of the stratospheric ozone layer ○ Eutrophication potential ○ Formation potential of tropospheric ozone photochemical oxidants ○ Acidification potential of land and water sources