LENSE METHODOLOGY FOR SUSTAINABILITY ASSESSMENT OF BUILDINGS


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Summary

LEnSE is a European research project that responds to the growing need in Europe for assessing a building's sustainability performance. The project draws on the existing knowledge available in Europe on building assessment methodologies.

The main objective of LEnSE is to develop a methodology for the assessment of the sustainability performance of existing, new and renovated buildings, which is broadly accepted by the European stakeholders involved in sustainable construction.

Keywords: Sustainable construction, methodology, building assessment, European approach, pilot test cases

1 Introduction

LEnSE, Methodology Development towards a Label for Environmental, Social and Economic Buildings, is a European research project that responds to the growing need in Europe for assessing a building's sustainability performance. The project draws on the existing knowledge available in Europe on building assessment methodologies.

The main objective of LEnSE is to develop a methodology for the assessment of the sustainability performance of existing, new and renovated buildings, which is broadly accepted by the European stakeholders involved in sustainable construction.

A first step in the project was to identify a set of sustainability issues which should be included in a sustainability assessment on building level. Starting from a 'long list' of issues collected from different sources, a refinement of the list was carried out based on the analysis of existing methods and literature, and an extensive consultation of stakeholders.

The second phase was the development of the actual assessment methodology. Based on the envisaged goals and outcomes of a building-level sustainability assessment, a structure and format of the methodology were developed. The detailed development of the assessment method for each of the issues formed an important part of the research activities in the project.

These two steps have been presented by the LEnSE project by means of two "Stepping Stone" publications. This paper is based on the articles in these two publications (see [1] and [2]).

To guarantee the usability of the developed methodology, it is being tested in practice using a prototype tool developed in the project. Testing is done on real projects/buildings in each of the partner countries. The results of these testing exercises are presented at the CESB07 conference.

2 Identification of sustainability issues for the LEnSE methodology

The main objective of this task was to review existing assessment methodologies – such as environmental assessment tools, cost calculation tools, calculation of energy performance, building rating systems, incentives, environmental risks etc. – in order to extract the sustainability issues in these methods. At the same time, information was collected on the success factors of these existing assessment methods in Europe.

The result of this reviewing exercise was a long list of possible issues to be included in the LEnSE sustainability assessment methodology. This list needed further refinement to become a sufficiently wide, but practically feasible set of sustainability issues.

2.1 Identification of sustainability issues

Sustainability includes environmental, social and economic issues. Due to this very broad scope of our study, many different fields had to be covered. The partners involved in this work have used a large number of documents, and particularly:

- **Environmental assessment tools**: LCA tools (e.g. LEGEP, ECO-QUANTUM, EQUER, ENVEST), studies regarding external cost, …
- **Building rating systems and existing labels**: GB Tool, BREEAM, LEED, GPR GEBOUW, ECO-BAU, ESCALE, …
- **Cost calculation tools**: LCC calculation, elements method, …
- **Calculation of energy performance**: EN13790, national tools used in building regulation, thermal simulation tools, …
- **Infrastructure tools**
- **Sustainability incentives**: tax credits, subsidies, green certificates, energy certificates, …
- **Existing review reports** e.g. International Energy Agency
- Previous European projects: PRESCO, CRISP, BEQUEST, ECO-HOUSING, …
- Existing standards and draft standards: ISO, CEN, AFNOR, …

This review resulted in a first "long list" of issues. This list was optimised and refined, in order to result in a clear and workable list. Several research methods were used to achieve this:

- Frequency analysis of measures and issues included in existing methods
- Analysis of responses to a European LEnSE questionnaire dealing with the vision on sustainable construction of different stakeholders
- Outcome of the first series of national stakeholder meetings, organised in each of the LEnSE partner countries
- Findings from case studies and interviews
- Restructuring the different issues to minimise overlap and gaps from the long list

This long list was then reviewed and critical issues were identified in order to create a more concise list of issues. In defining the short list two guiding principles were followed;

- That the scope of issues included is sufficiently wide to cover the relevant sustainability topics.
- Each issue is practical in terms of developing content and completing an actual assessment.

This resulted in a shortlist of issues (**Tab. 1**) arranged into eleven categories. Each category in turn represents either an environmental, social or economic sustainability theme.

Tab. 1 LEnSE overview of issues for sustainability assessment of buildings

Theme	Category	Issue
Environment	**Climate Change**	Reduce Greenhouse Gas Emissions
	Biodiversity	Minimise Eutrophication
		Mitigate Impact on Site Ecology
		Enhance Site Ecology
	Resource use and Waste	Minimise Waste Production (solid, sewage, hazardous and radioactive)
		Minimise Primary Energy Consumption (embodied, operational and renewability)
		Limit Raw Material Use and Source renewable/recycled/responsibly sourced materials
		Minimise Water Consumption (reduce use and maximise reuse)
		Minimise Land Consumption (reduce total use and maximise reuse of contaminated land/brownfield sites)
	Environmental Management and Geophysical Risk	Improve Environmental Management
		Limit Climatological Risk (including flooding)
		Limit Geological Risk (including subsidence and erosion)
Social	**Occupants' Well Being**	Improve Visual Comfort (internal and external lighting provision)
		Improve Thermal Comfort
		Improve Acoustic Comfort and Vibrations
		Improve Indoor Air Quality (odours, ventilation and humidity)
		Improve Water Quality
		Improve Outdoor Comfort
		Ensure Provision of Privacy
		Reduce Exposure to Hazardous Materials/Substances (including radiation and electromagnetic fields)
		Avoid Unsafe or Hazardous Features (including topography)
		Avoid Accumulation of Intruding Hazards (radon, dust, pollen)
		Provide Health Targets
	Accessibility	Improve Access to Public Services and Amenities
		Improve Access to Public Transport
		Improve Accessible Pedestrian Network

		Improve Accessible Bicycling Network
		Facilitate Car Pooling
	Security	Improve Security of Buildings and Surroundings Against Crime
	Social and Cultural Value	Community / Stakeholder Consultation with Ongoing Participation
		Social and Ethical Responsibility (including probity & transparency)
		Sensitivity to the Local Community
		Provide Affordable Housing
		Building Aesthetics and Context
Economic	**Whole Life Value**	Reduce Whole Life Costing
		Preserve or Improve the Quality and Asset Value of the Site
		Increase Ease of Building Adaptability
		Improve Ease of Maintenance
		Contribute to Image Value and Technical Innovation
	Financing and Management	Improve Economic Feasibility
		Reduce Construction and Financing Costs
		Improve Construction and Management Standards
	Externalities	Optimise diverse and Long-term local Employment Opportunities, and Minimise Displacement.
		Use and Purchase locally Produced Materials
		Improve Building User Productivity

2.2 Success factors of assessment methods in Europe

In LEnSE, the aim is to develop a methodology which is accepted by the stakeholders. In order to increase our chances of success, it was deemed to be important first to understand better why some of the existing tools were successful, and why others have failed. To do this, information has been collected and a review of the LCA and rating tools took place:

- the purpose of the tools (design, policy making, research…),
- the users (designers, constructors, end users…),
- the focus (building, site, neighbourhood…),
- the building types (residential, tertiary…),
- the life cycle phases (design, construction, operation, refurbishment, demolition),
- the number of issues covered,
- the number of users,
- the time / cost needed to perform an assessment, including collection of input data (but excluding regulatory assessments),
- the incentives to use the tool (e.g. subsidies according to the result of the assessment),
- the source of funding (public, private) for the development and maintenance of the tool,
- the scientific credibility of the assessment and certification process.

From this information and from the review presented above, some trends can be derived regarding the strengths, weaknesses, opportunities and threats of the different approaches. These elements are summarized in the SWOT matrices below (**Tab. 2** and **Tab. 3**).

LCA methods

Tab. 2 SWOT matrix for LCA methods

Strengths	**Weaknesses**
▪ LCA tools are based upon a standardised methodology (ISO 14 040) ▪ The results can be checked as far as the assumptions are published ▪ Validation work exist, e.g. 8 tools have been compared in the PRESCO thematic network, showing a +/- 10 % discrepancy on CO2 emissions of the studied cases ▪ Some tools are user friendly, making the assessment as easy as simplified methods ▪ Some tools have a large number of users (e.g. ENVEST : 233 registered users) ▪ Some tools are linked with economic or social issues (LEGEP with life cycle cost, EQUER with thermal comfort)	▪ LCA concerns only some environmental issues, that can be evaluated in a quantitative way ▪ Some harmonisation work is still needed among the different tools in Europe ▪ LCA tools require data that may not be available (e.g. life cycle inventories of locally produced materials, or technical innovation) ▪ The number of users of LCA tools is generally limited (still more researchers than professionals)
Opportunities	**Threats**
▪ A European project aims to develop a data base including life cycle inventories of building materials (JRC, Ispra) ▪ LCA is considered in CEN TC 350 in charge of sustainable building ▪ Incentives could be provided according to environmental performances evaluated using LCA ▪ Continuing education could allow building professionals to be trained	▪ LCA could be rejected as being too complicated by building professionals ▪ The cost of an assessment must remain low to ensure the acceptance of a labelling process

Rating tools

SWOT matrix for rating tools

Strengths	**Weaknesses**
▪ Rating tools include more easily all kind of issues (social, economic, environmental), including qualitative issues ▪ Rating tools are generally user friendly, the input and output being adapted to both building professionals and clients ▪ Some rating tools are partly based upon LCA, which may increase their reliability ▪ Some tools are widely used (e.g. 25,000 accredited LEED professionals in the U.S., over 1,000 BREEAM assessors)	▪ Qualitative evaluation is very difficult to validate : the confidence in the result of a rating tool is sometimes limited ▪ Many tools exist, which can be very different in their structure and content

Opportunities	Threats
▪ An increasing number of owners apply for "green labelled" buildings ▪ A harmonised methodology can emerge from European research and standardization activities	▪ Labelling low performance buildings reduces the credibility of labelling ▪ Agreeing on a common qualitative assessment method may be difficult and the result may depend a lot on the assessor

3 Content of the LEnSE assessment methodology

3.1 General approach

The work carried out in the first phase of the project resulted in the above mentioned set of sustainability issues. It is important to recognise however that this short list represented a set of sustainability issues, but these in themselves are not necessarily measurable criteria. It was necessary therefore, in the second phase of the project, to translate these issues into groups of sub issues. These sub issues would be representative of the initial short list and the principles of the structure of the methodology. In doing so this would shift the focus from the intent of the issues on to indicators of sustainability performance, therefore progressing development of the method's content.

Definition and categorisation of each sub issue was guided by the following principles:
- Appropriate to each class of building considered i.e. commercial/public and residential.
- Account for, and be applicable to the key stages in the building life cycle i.e. planning/design and operation.
- Applicable EU wide, but flexible enough to allow for crucial local or regional issues to be included and accounted for.
- Facilitate the use of outputs from other methodologies and standards as a method of complying with a sub issue. For example the use of existing country specific LCA tools and methodologies or process based standards or codes of practice.
- Result in an output that represents an indicator of a buildings sustainability performance, not necessarily a holistic representation of performance.
- Bear in mind that evaluating final performance, once the relevant information has been collated, should take no longer than 2 days.
- Ensure consistency with the initial consultation and identification of sustainability issues, and the subsequent long and short lists from work package one.

In total 56 sub issues were identified, related to 11 categories within the 3 sustainability themes, environment, social and economic.

3.2 Weighting and performance evaluation

The approach to weighting and scoring sub issues and categories provides the basis for the structure of the methodology. For LEnSE it is proposed that performance of a building, measured against each sub issue and category, will be ranked on an A-G scale. Overall building performance will also be ranked on an A-G scale, determined via the accumulation of individual category scores.

Each A-G category and sub issue benchmark will be determined by a consensus based weighting exercise.

The weighting exercise constituted of two parts:

3.2.1 Weighting each LEnSE category in terms of its relative importance

This approach will use international consensus to determine a weighting for each category. In addition to this approach, a proportion of the overall weighting will be influenced by national consensus. This allows each country to fine tune the weighting for a category according to national priorities. For example, a category containing a sub issue concerning radioactive waste may be more relevant in France than Italy. A French version of the methodology may therefore weight that category with more importance than the Italian version.

3.2.2 Weighting each sub issue within a category

Using the weighting for each category, version specific sub issue weightings can then be determined. This is done by distributing the overall category weighting between the sub issues according to the national consensus. The table below provides an example of this for the climate change category.

The sub issue weighting is split and apportioned to each of the A-G performance bands for each sub issue within a category. Then, in an actual assessment, the performance of the building is compared against the benchmark scale for each sub issue. This will determine the sub issue rating and its equivalent number of weighting points. For example, a UK assessed building that achieves a CO_2 emission rate of 42 $KgCO_2/m^2$ achieves a sub issue rating of C and 50 weighting points; as highlighted in the table below.

Tab. 3 Example of relationship between sub issue benchmark and weighting

Category	**Climate Change**				
Sub issue	**Building - depletion of non renewable primary energy**				
Sub issue rating	**Benchmark**	**Available Weighting**			
		UK	**France**	**Bel**	**Greece**
	$KgCO_2/m^2$	*70*	*45*	*60*	*140*
A	<15	70	45	60	140
B	<30	60	39	51	120
C	<45	50	33	42	100
D	<75	40	27	33	80
E	<105	30	21	24	60
F	<120	20	15	15	40
G	<135	10	9	6	20

On completion of the assessment of each sub issue, the amount of weighted points achieved is accumulated. This in turn translates into a category rating and weighted score. The accumulation of weighted points in each category then translates in to an overall LEnSE rating for the assessed building.

3.2.3 Important note

It is important to note that the LEnSE project does not aim to achieve this kind of international consensus within the scope of the current development work. This could

rather be the subject of future research activities in this area. For the pilot test cases however, a provisional weighting of the categories will be adopted, based on a consensus within the project team.

3.3 Sub issue development

After the definition of the structure and content of the methodology the emphasis of the project has shifted to developing a limited, but representative range of sub issues.

When choosing which sub issues to develop the project team decided to avoid developing too many that were included in, and assessed by existing methodologies. The aim is to avoid repetition of research, where possible, and uphold the principle of allowing existing methods, and their application, to potentially compliment the application of LEnSE.

It was felt, in addition, appropriate not to develop too many sub issues that were covered by the scope of CEN/TC 350 (Sustainability of Construction Works – framework for the assessment of integrated building performance). It is the intention that LEnSE should take a steer from efforts to develop international standards to ensure it adopts an approach consistent with such standards.

The development of content for the method therefore aims to focus on those issues under-represented by existing assessment methodologies and standards. This decision is, however, balanced with the need to ensure adequate representation of each sustainability theme.

In total 30 sub-issues were developed by the LEnSE partners, covering equally all three categories of sustainability. An example of a complete developed sub-issue assessment for “Provision of car pooling” is given just below.

3.4 Example of sub issue: PROVISION OF CAR POOLING

3.4.1 Intent

The provision of key amenities in proximity of the building encourages sustainable and integrated communities. Easier access to such facilities also reduces transport related greenhouse gas emissions.

3.4.2 Performance Benchmark

The building’s performance must be determined by measuring the distance to all relevant amenities in proximity of the assessed buildings main entrance, and compared to the following:

Tab. 4 Benchmark: Building occupants per parking space and car share policy objectives

Level	Requirements
A	2.3 users per parking space and at least 5 car share policy objectives
B	2.2 users per parking space and at least 4 car share policy objectives
C	2.0 users per parking space and at least 3 car share policy objectives
D	1.7 users per parking space and at least 3 car share policy objectives
E	1.5 users per parking space and at least 2 car share policy objectives
F	1.3 users per parking space and at least 1 car share policy objectives
G	1.2 users per parking space and no car share policy objectives

3.4.3 Requirements

Step 1: Determine the number of building occupants per parking space

Divide the number of building occupants by the number of dedicated parking spaces provided for those building occupants.

Note:

- If the number of building occupants is not known, use a national figure of one person per 10 m² of net floor area.
- For existing buildings, company staff travel surveys can be used to determine the actual proportion of building users that car share.

Step 2: Determine the number of car pooling policy objectives implemented

Car pooling policy objectives

- Provide general information about car pooling and encourage participation (i.e. demonstration of benefits through message board announcements).
- Continuous promotion of car pooling through formal announcement(s) and adoption of documented policy that covers eligibility, incentives, penalties for non-compliance, guidelines etc.
- "Meet Your Match" events or registration of employees/users in a computer/internet based match-up and ridesharing service.
- Establishment of incentives for car pooling such as: preferred or premium parking spaces i.e. near main entrance sheltered and/or attended; lower parking fees; free parking passes; provision for an emergency ride home (ERH) scheme; reward programs etc.
- Make car pooling service available to local community (non building users).
- Periodic assessment and re-evaluation of car pooling activity (i.e. car pooling data processing, surveys to determine employee's/user's current transportation patterns and interests, feedback from car-poolers etc.).
- Eliminate potential car pooling fraud (i.e. implementation of carpool parking in gated or attended parking areas).

Note:

- For a design stage assessment, there must be a firm commitment to implement any relevant car share policy objectives post construction, during the operational phase. This commitment must be provided in order to award the building a specific LEnSE rating for this sub issue.

3.4.4 Supporting documentation

Type of information required to complete the assessment	New buildings or renovations		Existing buildings	
	Non domestic	Domestic	Non domestic	Domestic
Site plan	◆	-	-	-
Net building floor area (m²)	◆	-	-	-
Number of full time equivalent building occupants at time of assessment	◆	-	◆	-
Summary results from a company specific travel plan	-	-	◆	-
Relevant car pooling/transport policy documents *)	◆	-	◆	-
Written commitment outlining which policy objectives will be implemented and over what time period	◆	-	-	-

*) The documents should be provided by the administration or by a special transportation office and include, but not necessary limited to leaflets, message board announcements, memos, policy papers, reports, surveys, database records.
Random interviews with employees/users of the building are also recommended.

3.4.5 Additional information

Studies in Europe and elsewhere estimate that the average car occupancy is 1.2 passengers per vehicle per trip. Case studies show that effective car pooling can raise occupancy level above 2.0. Thus, it is expected that assessed buildings should at least achieve the standard average of 1.2 to be eligible for benchmarking under this sub-issue.

4 Pilot test cases

The LEnSE methodology and developed sub-issues is tested on actual buildings, the so called "pilot test cases". This action plays a vital role in the project as this is the phase where theory becomes practice for the first time and valuable conclusions can be drawn.

4.1 The prototype tool

The development of a prototype assessment tool allows for the testing of the method on actual buildings. The content of the tool is derived directly from the development of the issues as described above. It has been decided by LEnSE partners that a limited but representative number of issues will be fully developed and included in the tool for the purpose of testing the methodology. Consequently, this resulted into 30 issues being integrated in the prototype covering equally all three categories of sustainability (Environmental, Social and Economic).

In terms of format, it was agreed that an Excel based approach was the most convenient means for the testing of the methodology, providing a familiar and easy-to-work-with environment for the partners assessing the pilot buildings.

4.2 The pilots

Actual testing of the method started in July 2007 on a total of ten case study projects. Though the scope of the method developed under LEnSE project encompasses different types of buildings during their entire life-cycle, it is decided that for testing purposes focus should be given on two types of buildings, Residential and Office during their design/construction or early occupational stage only. Each partner will carry out one pilot assessment in their respective country.

The pilot test cases using the prototype are expected to give valuable feedback to the methodology development process. The near Europe-wide testing could identify any possible shortcomings of the assessment methodology allowing for a robust final product. Benchmarking against developed issues will also be tested and verified on actual cases also allowing for adjustments and re-evaluation.

Furthermore the pilots will give the partners a notion about the length and time required to complete the assessment. For the method to gain stakeholders' acceptance it is expected that the assessment of any building under the LEnSE method should be carried out by an assessor, after having obtained all the required building data, in no more than two or three days. Finally, the test cases should allow us to validate in practice the double role

of the methodology as pointed out at an earlier stage of development; to both assess the building against sustainability and at the same time to be able to identify areas of future improvement.

The results of this testing process will be presented in detail at the LEnSE workshop at CESB 07 PRAGUE Conference.

5 Conclusions

LEnSE is a European research project that responds to the growing need in Europe for assessing a building's sustainability performance. The project draws on the existing knowledge available in Europe on building assessment methodologies.

LEnSE established a long list of sustainability issues based on a review of existing assessment methodologies and reduced this long list to a short list of eleven categories with 45 issues that are considered as sufficiently wide to cover sustainability and practical enough to be assessable. This LEnSE shortlist is on its turn translated to groups of sub issues, that allow a definition as measurable indicators of sustainability performance.

In total a selection of 30 sub-issues were developed by the LEnSE partners, covering equally all three categories of sustainability. A prototype assessment tool allows for the testing of the developed method and sub-issues on 10 actual buildings. The results of this testing will give valuable feedback to the methodology development process and will be presented in the LEnSE workshop at CESB 07 PRAGUE Conference.

LEnSE Partners: Belgian Building Research Institute, Belgium; ARMINES – ENSMP, France; Building Research Establishment, United Kingdom; Bauphysikbüro Oliver Kornadt und Partner, Germany; Imperial College, United Kingdom; PIODE + W/E Consultants, Netherlands; Planair, Switzerland; Czech Technical University, Czech Republic; European Profiles, Greece

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References

[1] LEnSE Stepping Stone 1, *Sustainability assessment of buildings - Issues, scope and structure*, Publication of the LEnSE project, Amersfoort, November 2006

[2] LEnSE Stepping Stone 2, *Development of a sustainability assessment methodology - Framework and content*, Publication of the LEnSE project, Amersfoort, March 2007

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