# STUDY FOR THE DEVELOPMENT OF EUROPEAN ECOLABEL

# CRITERIA FOR BUILDINGS

**First background report**

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# Summary

# 1. Foreword

The main purpose of this report is to provide background information in order to identify the main environmental aspects for the development of European Ecolabel criteria for the product group "Building".

This background report provides results of investigations and researches carried out according to the product group definition proposed in the report "Product group definition" dated August 2008 where a proposal for the product group definition was made as follow:

"Buildings considered in their entirety, as well as small houses, new or existing, public or private, used for residential purpose and for use as offices".

The following considerations were also proposed:

- From the definition part of the building such as dwellings are excluded;
- New buildings include also major refurbishments.
- Existing buildings include also renovations.
- Residential purpose is meant as for dwelling purpose.
- Use as offices is meant to be the use of the building for administrative, bureaucratic and educational activities of a public or private nature.

According to the product definition proposed the researches have been focused on the main environmental aspects which emerge from the different LCAs studies analysed.

The main environmental aspects have been organised according to the different phases occurring in the life cycle of buildings.

Particular attention has been devoted to specific aspects related to the peculiarity of this product group such as for example the "fitness for use" aspect.

At the same time an analysis of some selective environmental Ecolabels has been conducted in order to point out the most used criteria according to the main environmental aspects identified and for the different life cycle phases.

The analysis carried out includes the type of the existing criteria and the indicators used by CEN TC 350 for sustainability assessment of buildings.

A specific chapter has been also devised to Green Public Procurement criteria already elaborated at European level especially for construction materials.

The report contains the following main chapters:

- The identification of environmental aspects according to LCA case studies with a specific focus on energy aspects;
- The analysis of existing criteria of national and international Ecolabel schemes on buildings with the inclusion of CEN/TC 350 indicators and indicators included in the CPR proposal;
- GPP criteria for construction materials;
- Proposal for main issues to be considered for criteria development.

We would like to remind that this report is the natural next step following the report for the Product group definition (August 2008) and the Preliminary Report (April 2008) finalised to provide a the legislation, economic and environmental context for the buildings criteria development. In the

Preliminary Report have been also examined the majority of the existing environmental certification schemes available at international al European level.

We are pleased to remind that all documents are available at the both ISPRA and European Commission web site:

http://www.apat.gov.it/certificazioni/site/it-IT/Ecolabel/Documentazione/Prodotti/

http://ec.europa.eu/environment/ecolabel/product/pg_buildings_en.htm

# 2. Main environmental aspects

## 2.1 INTRODUCTION

The main impacts of buildings are: territory consumption, emissions in atmosphere, energy and water consumption, waste. The key principles to reduce these impacts are:

- ✓ Minimize life-cycle costs
- ✓ Reduce resource consumption
- ✓ Reduce resource waste
- ✓ Increase equipment and system efficiency
- ✓ Emphasize source and waste reduction
- ✓ Create healthy environments

The process of building follows these phases:

- ✓ planning
- ✓ construction process
- ✓ maintenance and operational
- ✓ Demolition and disposal.

The process of creating a high environmental performance building is different from the conventional design/build process. The goal is to significantly reduce or eliminate the negative impact of buildings on their occupants and on our environment. The sustainability goals must also support the project's goals for function, aesthetics, security, cost, and schedule. The challenge is to integrate environmental goals without compromising any of the project needs and objectives.

The content of this chapter has been taken by the following documents:

- o Jane Anderson and Suzy Edwards, Centre for Sustainable Construction, BRE, DETR Framework Project: Support for Government Policies on Sustainable Development, Addendum to BRE Methodology for Environmental Profiles of Construction Materials, Components and Buildings, July 2000
- o http://ecm.ncms.org/ERI/new/IRRconstruc.htm#impacts, Highway and Building Construction Impact Risks and Regulations.

## 2.2 LIFE CYCLE PHASES

### 2.2.1 Planning

The ***planning or design phase***, considers all building components and systems and integrates them to work together. Because all the systems are interrelated, it is essential that the design team be fully integrated from the beginning of the process. The building design team can include architects, engineers, building occupants and owners, and specialists in areas such as indoor air quality, materials, and energy use. It's necessary to consider site, energy, materials, indoor air quality, acoustics, natural resources, and their interrelation. Further duty is to take into consideration the building structure and systems and examine how these systems work best together to save energy and reduce environmental impact.

The objective is to improve site planning; to safeguard water and ensure its efficient use; to maximize energy efficiency, conserve materials and resources and ensure indoor environmental quality.

The benefits:

- ✓ Reduced energy and water use
- ✓ Lower maintenance and capital costs
- ✓ Lower environmental impact
- ✓ Enhanced occupant comfort and health
- ✓ Higher employee productivity

**Reduction measures at the development/design stage**

Any measures that can be undertaken to reduce the amounts of waste generated in the first place will provide the most sustainable solutions. Reduction of waste could be enhanced by:

- ✓ Encouraging building owners and developers to embrace the concept of waste minimisation and recovery of resources. Project briefs should address waste avoidance, building adaptability and life cycle analysis.
- ✓ Designing buildings to avoid waste wherever possible.
- ✓ Designing building structures to enhance the ability to deconstruct and dismantle rather than demolish.
- ✓ Designing buildings to enhance their ability to be adapted for different uses. This adaptability will increase the economic life of any structure and decrease the chance of premature demolition.
- ✓ Establishing a task force with representatives from recyclers, building materials manufacturers, building designers, and building/demolition contractors to investigate waste reduction measures and provide co-ordination across industry sectors.
- ✓ Ensuring waste management issues are considered during the development process; for example, by requiring waste management planning as part of the development application.

### 2.2.2 Construction

The main impacts from the second phase, construction activities, are direct and significant to environmental profile.

The direct impacts are air pollution, noise, vibration, water quality, traffic flow, and visual impacts for residents.

Construction activities such as site preparation, demolition, excavation, vehicle movement, and material transport release dust particles into the atmosphere. Other air emissions from trucks and equipment use increase the traffic due to construction vehicles, material delivery, and workers accessing the site.

Construction noise and vibration impacts are engendered by equipment that include excavators, concrete pumps, concrete trucks, hydraulic cranes, rubber tire backhoe and loaders, dump trucks, hi-lift forklift, air compressors for pavement breakers and welding machines.

Major types of environmental risk associated with the impacts include:

- ✓ Earth-moving, removal of vegetation, filling of wetlands, and similar activities can severely degrade habitat.

- ✓ Runoff from dewatering and storm water can erode the site, and can cause downstream degradation of water resources.
- ✓ Heavy equipment exhaust can degrade air quality through fine particulates and ozone precursors.
- ✓ VOC emissions through paint and cleaning solvents and other materials can also help create ground-level ozone.

**Environmental management of the construction phase**

Measures could include:

- ✓ Requiring Waste Management Plans as supporting documentation in the tendering process for any project.
- ✓ Recycling and reuse proposals as criteria in the selection process for the awarding of contracts.
- ✓ Nominating a person on site to be the Waste Management Officer and giving them the authority and accountability for ensuring cost effective results.
- ✓ Including waste minimisation/management issues as part of the site induction process for all personnel, including contractors.
- ✓ Including waste minimisation outcomes as key performance indicators to be reviewed at all site management meetings and evaluated at the end of the project.
- ✓ Undertaking discussions with all suppliers to review ways of reducing waste. For example, cutting to size at the factory to minimise on-site cutting, or decreasing unnecessary packaging of building products through bulk deliveries.
- ✓ Requiring construction material suppliers to take back surplus materials.
- ✓ Accurately estimating quantities to prevent excess materials being delivered to site.
- ✓ Employing techniques so only the required materials arrive on the construction site at the appropriate time. This will allow increased space allocation for waste separation and the positioning of skips for recyclable waste products.
- ✓ Matching the skips for recyclable products to the different stages of construction, thus optimising space.
- ✓ Including waste management issues as part of the building inspection/control and certification process.
- ✓ Developing disposal procedures such as the types of containers to be employed, clear and appropriate signs, a suitable location for bins and stockpile sites and allocation of areas to place materials for recycling/reuse.

### 2.2.3 Use phase

To create an effective maintenance and operational program, the general procedures should be followed:

- ✓ Ensure that up-to-date operational procedures and manuals are available.
- ✓ Obtain up-to-date documentation on all building systems, including system drawings.
- ✓ Implement preventive maintenance programs complete with maintenance schedules and records of all maintenance performed for all building equipment and systems.

- ✓ Train the maintenance staff and offer professional development and training opportunities for each staff member.
- ✓ Implement a monitoring program that tracks and documents building systems performance to identify and diagnose potential problems and track the effectiveness of the maintenance and operational program. Include cost and performance tracking in this analysis.

Specific elements of this program include:

*Heating, Ventilation, Air Conditioning Systems and Equipment*
Energy consumption and conservation are tied heavily to maintenance and operational procedures. This equipment must be well maintained for the complex array of chillers, boilers, air handlers, controls, and other hardware to function at peak performance. Easy access to these systems for ongoing maintenance and repair is critical (be sure that this is considered during design). A well-thought-out, well-executed maintenance and operational program can provide huge savings in equipment and energy costs.

*Indoor Air Quality Systems and Equipment*
Air ventilation and distribution systems should be well maintained and frequently checked for optimal performance. Coordination between air distribution systems and furniture layouts is especially important. In addition, regular inspection for biological and chemical contaminants is crucial. Poor indoor air quality lowers productivity, can cause illness, and has resulted in numerous lawsuits.

*Cleaning Equipment and Products*
Using biodegradable and least-toxic cleaning products and equipment can reduce both maintenance and operational costs and pollution to air and wastewater streams while improving both indoor air quality and worker productivity. The need for chemical cleaning products can also be reduced through environmentally conscious design and material choices. New requirements for cleaning contracts must be clearly specified.

*Using materials*
Facilities should maintain an attentive and proactive approach with regard to the environmental impacts of their material choices. Every day new products, systems, and equipment, which have fewer adverse environmental impacts, become available. All these choices should be carefully scrutinized.

*Water Fixtures and Systems*
Routine inspections and maintenance programs for water fixtures and systems are crucial. Population growth and development have reduced the availability of high-quality, potable water in many regions of the country. Along with increased water prices, reduced supply often leads to usage restrictions. It's important reduce operating costs when it verifies that fixtures and systems are functioning effectively and ensures that leaks or components are quickly repaired.

*Waste Systems*
Recycling and waste-reduction programs and their supporting hardware need frequent attention and maintenance in order to function at peak performance.

*Landscape Maintenance*
Use of native plantings can reduce landscape maintenance and operational requirements and costs significantly. Although natural vegetation may take several years to become established, once it is established there is usually less need for water. Integrated pest management can also reduce overall maintenance and operational costs by reducing the need for hazardous chemicals and pesticides.

### 2.2.4 Demolition and disposal

It's relevant to salvage of construction and demolition waste material from the construction site for resale or reuse by others. In order to be recyclable, materials must be separated from contaminants (e.g., trash, nails, and broken glass).

The demolition of buildings produce a variety of wastes, including the following: wood, concrete, brick and block, asphalt, glass, paint, roofing materials, tile, insulation, plastic, lead pipes, ferrous and nonferrous metals. Some wastes, such as asbestos and refrigerants, require careful and perhaps expensive handling techniques in order to avoid endangering public health or environment.

The benefits from reducing the amount of waste include:

- ✓ reduced waste disposal costs
- ✓ avoid landfill consumption
- ✓ preservation of environmental quality
- ✓ improved workplace safety and health

Various materials resulting from demolition activities can be used again in new construction projects rather than disposed of. Some reusable items are:

- ✓ bricks and blocks
- ✓ doors and windows
- ✓ plumbing fixtures and pipes (provided they don't contain lead)
- ✓ electrical fixtures and wiring

Many materials generated in building demolition can be processed in some way and the used as a raw material in construction projects or for other purposes. Here are some examples of recyclable demolition materials:

*Aluminium.* All aluminium is recyclable, but only small percentage of the aluminium used in construction gets recovered and recycled.

*Other metals.* Metal is a valuable recyclable material.

*Wood.* There are numerous possible uses for old wood, including such things as mulching or chipping for use in landscaping or gardening, or as fuel.

*Asphalt.* Old asphalt can be recycled. A new asphalt mixture can contain up to 10% of old asphalt milled from road construction or roofing shingles.

*Concrete.* Waste concrete -- the single largest category of demolition waste -- can be crushed and used as an aggregate or a base material. A very small percentage of waste concrete is currently being recycled.

Planning a deconstruction project, of any scale, require careful consideration.

The construction and demolition waste is an important component of the solid waste stream. This waste should be recognised as a valuable resource as large quantities of it could either be recycled or reused trough preventive actions.

## 2.3 ENVIRONMENTAL IMPACTS AND RISKS

Air Quality:

- ✓ NOx and fine particulates from Diesel engines

- ✓ Dust
- ✓ Visibility of stack emissions from off-road equipment
- ✓ Cumulative effects of emissions from paint and other solvents

Water quality:

- ✓ Dewatering and storm water runoff
  - o sediment loadings
  - o erosion of stream banks scouring of stream beds due to excessive flow volume
  - o habitat degradation
  - o pollutant and excess nutrient transport

Solid waste:

- ✓ Quantity of materials disposed to landfills
- ✓ Toxicity of some materials used in construction and related activities, including
  - o paints
  - o cleaning solvents
  - o fuels and lubricants
  - o concrete (high alkalinity)
  - o curing compounds
  - o chlorinating compounds (from well and water supply line chlorination)
  - o fertilizers and pesticides from landscaping operations
- ✓ Potential use and related restoration activities for contaminated soil
- ✓ Provisions for reusing or recycling of unused materials
- ✓ Provisions for making use of materials with recycled content

Site impacts:

- ✓ Habitat destruction
- ✓ Situations involving special regulatory considerations, including:
  - o Wetlands
  - o Endangered species
- ✓ Potential for contamination from stored materials, spills
- ✓ Preservation of vegetation, or re-vegetation, as appropriate

# 3. A focus on energy

## 3.1 INTRODUCTION

The following chapter presents some possible, not complete, examples of criteria related to Energy aspects in buildings.

Such examples even if refer only to the Italian legislation are useful examples as the methodology used was in common.

It is important to point out that in relation to the European Ecolabel criteria the energy aspects will be tackled taking into account the European Energy Performance of Buildings Directive and its applications in the Member States. In this context European Ecolabel criteria will refer to the highest energy performance levels identified by the national implementation or to a rating scale.

## 3.2 INDICATORS OF ENERGY PERFORMANCES

The general objective of this chapter is to propose a set of indicators for energy performances of buildings which allow evaluating:

- Minimal requirements for mandatory performances;
- Additional requirements in order to achieve a minimum score to award the European ECOLABEL.

Concerning the first point it is necessary to consider the application of the **Ecolabel methodology also to existing buildings**. This allows to enlarge considerably its application and to improve the environmental and energy quality of buildings. Nevertheless minimum requirements for existing buildings should be differentiated to those of new buildings according to the evolution of technical legislation (i.e. in Italy law n. 373 del 76, law n. 10/91 and the recent dlgs 192/05 modified with dlgs 311/06).

Concerning the energy performances, a differentiated approach has been adopted for instance in the Minergie Ecolabel also agreed by UEAPME.

A second need is to differentiate evaluation criteria but also indicators **according to the destination use**.

### 3.2.1 Energy performances

A sharable and feasible proposal for the definition of Energy criteria for the European Ecolabel should be based on an **energy performance references at national level**, according to the implementation of the Energy efficiency directive for buildings in the different European countries.

Concerning the Energy performances of buildings some of the following indicators could be used: some of them are referring to the entire building and others to specific and peculiar characteristics of some building components (such as U value– W/m2 K, etc.).

This approach could better guarantee in general terms

1 energy quality for winter conditioning

2 energy quality for summer conditioning

3 energy quality for hot water production

4 energy quality for electric use

### 3.2.2 Energy quality for winter conditioning

#### a. Total consumption of primary energy for winter conditioning

This aspect is directly linked to the Energy consumption of the building, therefore to the related environmental impact for winter conditioning. Examples of mandatory and additional requirements for this aspect are:

| | |
|---|---|
| Mandatory requirement | For new buildings limits reported to annex C dlgs 311/06, in function of the climatic zone and of Ratio S/V. For existing buildings an alternative criterion is needed (for instance requirements in the construction phase or corrective coefficient to apply to minimum limits required by the law 311). Unit measure is kWh/$m^2$ year or kWh/$m^3$ year. |
| Additional requirement | Checking if the primary energy consumption of building is less than a value established using a score system based on the ratio between the real energy consumption and the minimum level. |

#### b. Energy performance of building envelope.

The reference value is the average U of the walls, opaque and transparent, which define the envelope of the building. Examples of mandatory and additional requirements are:

| | |
|---|---|
| Mandatory requirement | For new buildings the limit value in terms of U value, as reported in annex C of dlgs 311/06, are increased of 30%, in relation to the climatic zone. For existing buildings instead an alternative criterion is needed. Unit measure is W/$m^2$ K. |
| Additional requirement | Average value of U of all elements which constitute the envelope loaded on the different surfaces. Calculation in order to assign to each surface the transmittance value reported in annex C of law 311/06 (always increased about 30%) and to obtain a new value of average transmittance. The ratio between the two average values of transmittance, the real one and the legal one, will be confronted with a score system. |

#### c. Controlled Ventilation

The mechanical controlled ventilation is able to guarantee a correct change of air. In this case, at least for residential buildings, mandatory requirements are not foreseen as not required by law. An example of additional requirement could be the following

| | |
|---|---|
| Additional requirement | for residential buildings, where mechanical controlled ventilation systems exist, it is possible to assign points according to the quality of the system. It would be advisable to award additional points to those systems which are using energy coming from RES. |

### 3.2.3 Energy quality for summer conditioning

Concerning the summer conditioning, unfortunately, in Italy are not available requirement which allow evaluating Energy performances in terms of primary energy consumption. There is no availability of legal requirements which allow establishing minimal requirements for primary energy consumption for summer conditioning.

**a. Building energy consumption for summer conditioning**

This aspect is directly linked to the Energy consumption of the building, therefore to the related environmental impact for summer conditioning.

| | |
|---|---|
| Mandatory requirement | Standards UNI-TS 11300 part I provide tools to evaluate the building energy consumption for summer conditioning considering as hypothesis a constant temperature of 26 °C. It would be necessary in this case to define minimum reference values which could be considered minimum requirements. |
| Additional requirement | Checking if the primary energy consumption of building is less than a value established using a score system based on the ratio between the real energy consumption and the minimum level. |

**b. Solar radiation control**

The solar radiation control through external or internal surfaces allows the reduction of thermic summer loads and therefore can be considered a quality element for the building.

| | |
|---|---|
| Mandatory requirement | For new buildings is considered mandatory an internal or external protection system from solar radiation for expositions located within East, South-East, South, South-West and West. |
| Additional requirement | For shading system if located outside the building. |

**(c. Thermic inertia)**

To keep comfort thermic conditions within internal spaces during the summer period avoiding air overheating.

**d. Conditioning systems using Renewable Energy Sources**

Award of conditioning systems using Renewable Energy Sources

| | |
|---|---|
| Additional Requirement | Conditioning systems using RES such as:<br>- refrigerators and photovoltaic system<br>- solar cooling<br>The score is assigned according to the covering of the summer thermic load. |

### 3.2.4 Energy Quality for production of heat sanitary water

**a. Energy from RES**

After having defined the standard consumption, calculated on the basis of UNI-TS 11300 parte II, the primary energy quantity according to the type of system should be evaluated. Then according to this evaluation, it can be calculate the % of energy from RES.

| | |
|---|---|
| Mandatory requirement | For new buildings shall be guaranteed a coverings of thermic load through using renewable energy sources with a contribution not lower than 50%. This requirement does not apply to existing buildings or if the building is linked to district heatings. |
| Additional requirement | If the % of RES vs total energy consumption is higher than 50%, better score can be achieved. |

### 3.2.5 Energy quality for electric use

**a. Energy efficient lighting systems**

Additional requirement Low consumption lighting systems.

**b. Devices for artificial lighting control**

Additional requirement Control Systems for artificial lighting.

**c. Electric energy from Renewable Energy Sources**

# 4. The indoor environment

This chapter provides a possible approach for the evaluation of the indoor wellness of buildings in order to elaborate a criterion on this specific aspect. The proposal comes from a research group of University of Palermo (Prof. G. Rizzo and Prof. M. Cellura).

## *4.1 INTRODUCTION*

It must be properly taken into account that a building is a very special "product". Actually its main mission consists in delivering suitable conditions to people living and/or working inside buildings. This prerequisite should be properly verified, before any environmental consideration regarding the building takes places and, of course, before discussing about the criteria for the attribution of an E.U. Ecolabel award.

As far as the fitness for use conditions are in context, it would be important referring the indoor performances of buildings to a common EU standard. This is now possible, due to the recent releasing of the EN 15251 European Standard concerning the parameters for assessing and drawing the energy performances of buildings addressing indoor air quality, thermal environment, lighting and acoustic issues.

In the framework of the EN 15251 standard it is proposed a classification and certification scheme for indoor environments to be included in the building energy certificate (Directive 2002/91/CE).

The ANNEX A of the regulation (Table 4.1) lists some examples of quality categories for the design of mechanically cooled and heated buildings, concerning the thermal comfort issue, evaluated by means of PPD (Predicted Percentage of Dissatisfied people) and PMV (Predicted Mean Vote) indices.

The ANNEX A also reports the indoor summer temperatures to be considered as acceptable for the design of buildings without a mechanical cooling system.

**Table 4.1: Examples of recommended categories for design of mechanical heated and cooled buildings.**

| Category | Thermal state of the body as a whole | |
|---|---|---|
| | PPD % | Predicted mean vote |
| I | <6 | -0,2 < PMV <+0,2 |
| II | <10 | -0,5 < PMV <+0,5 |
| III | <15 | -0,7 < PMV <+0,7 |
| IV | >5 | PMV < -0,7; OR +0,7< PMV |

The ANNEX I of the regulation, lists some interesting examples of classification and certification of the indoor environment (Table 4.2).

**Table 4.2: Classification based on criteria for energy calculation**

| Criteria of indoor environment | Category of this building | Design criteria |
|---|---|---|
| **Thermal conditions in winter** | II | 20-24 °C |
| **Thermal conditions in summer** | III | 20-27 °C |
| **Air quality indicator, CO2** | II | 500 ppm above outdoor |
| **Ventilation rate** | II | 1 l/sm2 |
| **Lighting** | | Em > 500 lx; UGR < 19; 80 < Rs |
| **Acoustic environment** | | Indoor noise < 35 dB(A)<br>Noise from outdoors < 55 dB(A) |

But, how showed in Figure 4.1, due to the complexity of the issue at hand, the difficulty to find the characteristic parameters of the indoor quality and, above all, the scarce knowledge about the reciprocal influence among the different aspects able to influence the indoor performances on the overall quality of the indoor environments, it is recommended that a comfort "footprint" is given for thermal conditions and IAQ conditions separately.

**Figure 4.1: Hypothesis of indoor environments classification proposed by the EN 15251 standard [1].**

**10 Classification and certification of the indoor environment**

**10.1 General**

The information of indoor environment of the building should be included with the energy certificate of the building (EPBD article 7) so that total performance of building can be evaluated. For this certificate the classification of indoor environment is necessary. For the certification it may be necessary to integrate complex indoor environment information into a simple overall indicator of indoor environmental quality of the building.

Due to the many parameters and insufficient knowledge on the combined influence of the indoor environmental parameters, it is recommended to make an overall classification based on only thermal environment and indoor air quality.

**10.2 Detailed classification and certification**

The evaluation of the indoor environment includes (1) thermal criteria for winter, (2) thermal criteria for summer, (3) air quality and ventilation criteria, (4) lighting criteria, (5) acoustic criteria. Classification of indoor environment can be based on showing the design criteria for each parameter, calculations or measurements over a time period (week, month, year) of relevant parameters like room temperature, ventilation rates, humidity, and CO2 concentrations. The basis of evaluation has to be specified in the classification and certification. An example is shown in Annex I.

**10.3 Recommended overall evaluation of the indoor environment and certification**

For the overall evaluation it is recommended that a comfort "foot-print" is given for thermal conditions and indoor air quality conditions separately. This can be shown as the percentage of time the indoor environment (temperatures, ventilation rates or $CO_2$ concentrations are within the different categories (I, II, III, and IV). Examples are included in Annex I.

## 4.2 FIRST PROPOSALS OF AGGREGATED INDOOR QUALITY INDICES

It is worthy underlining that the possibility to attribute an *overall* score to the indoor environments would be really helpful for a building classification process based on their indoor performances and, as a consequence, for the definition of a scheme for the attribution of ECOLABEL award.

For this reason, some methods have been recently introduced aiming to achieve the definition of an integrated index for the *overall* buildings quality.

In particular, Filippi et al., proposed a method, based on the regulation EN 15251, that achieve the evaluation of the *overall* quality of an indoor environment referring to six spheres of environmental performances: winter thermal comfort, summer thermal comfort, indoor air quality, lighting, air changes and acoustics. The reference parameters are discussed in Table 4.3.

In order to achieve the definition of a unique class of the indoor environmental quality, taking into account the six spheres above described, one proposes to work as showed in Table 4.4.

**Table 4.3: Example of a certificate related to the indoor environmental quality for a building used as an office**

| Criteria of indoor environment | Category of this building | Reference values | This building | | |
|---|---|---|---|---|---|
| | | | Values | Basis | Date |
| **Thermal conditions in buildings** | A | 21-23 °C | 21,2 -22,8 °C | Measured | Winter 2003 |
| **Thermal conditions in summer** | B | 23-26 °C | 24,0-25,7 °C | Simulated | 1999 |
| **Air quality indicator, $CO_2$** | A | 350 ppm above outdoor | 780 ppm outdoor 380 ppm | Long term maximum measured value | 2003 |
| **Ventilation rate** | A (low pollution materials) | 2 l/s $m^2$ | 2,3 l/s $m^2$ | Design | 1999 |
| **Lighting** | C | $E_m$ > 500 lx | $E_m$ = 370 lx | Measured | 2000 |
| | | UGR < 19 | UGR < 22 | From building documentation | |
| | | 80 < $R_a$ | $R_a$ = 82 | Based on specification of light bulbs | 2004 |
| **Acoustic environment** | B | Indoor noise < 35 dB(A) | 34 dB(A) | Measured | 2000 |
| | | Noise from outdoor < 55 dB(A) | 50 dB(A) | Measured | 2000 |

**Table 4.4: Scheme of attribution of a quality class to an indoor environment.**

| The building is to be consider into class … | when.. |
|---|---|
| **A** | All 6 comfort factors are in class A |
| **B** | 4 or more factors are in class A and 2 or minus are in class B |
| **C** | 2 or more factors are in class A and 4 or minus are in class B |
| **D** | All 6 comfort factors are in class B |
| **E** | 4 or more factors are in class B and 2 or minus are in class C |
| **F** | 2 or more factors are in class B and 4 or minus are in class C |
| **G** | All 6 comfort factors are in class C |
| **H** | 4 or more factors are in class C and 2 or minus are unclassified |
| **I** | 2 or more factors are in class C and 4 or minus are unclassified |
| **J** | All 6 comfort factors are unclassified |

**Source: Filippi et al, 2007**

This method lends itself to be easily used in the processes of environments certification. However, it does not allow attaining the definition of the overall quality of an apartment or a whole building.

Concerning this Pietrafesa et al. (2008) introduced another method that allows overcoming this shortcoming. They proposed two synthetic indices: the quality index of an environment (IQA) and the building quality index (IQE), referring to a single indoor environment and to the whole building, respectively.

In particular, the authors defined the following relations:

$$IQA = 100\,\bar{f}_I + 70\,\bar{f}_{II} + 35\,\bar{f}_{III}$$

with:

$$\bar{f}_I = \frac{\sum_{i=1}^{N_f} p_i f_{I,i}}{\sum_{i=1}^{N_f} p_i} \qquad \bar{f}_{II} = \frac{\sum_{i=1}^{N_f} p_i f_{II,i}}{\sum_{i=1}^{N_f} p_i}$$

$$\bar{f}_{III} = \frac{\sum_{i=1}^{N_f} p_i f_{III,i}}{\sum_{i=1}^{N_f} p_i} \qquad \bar{f}_{IV} = \frac{\sum_{i=1}^{N_f} p_i f_{IV,i}}{\sum_{i=1}^{N_f} p_i}$$

where $N_f$ is the number of factors taken into consideration, $f_{I,i}$, $f_{II,i}$, $f_{III,i}$ ed $f_{IV,i}$ the portions of time in which the *i*-th parameter fell within the *I*, *II*, *III* or *IV* category and $p_i$ is a weighting factor, which can have the same value for each parameter or can vary.

Besides:

$$IQE = \frac{\sum_{i=1}^{N_a} k_i IQA_i}{\sum_{i=1}^{N_a} k_i}$$

where $N_a$ is the number of environments, $IQA_i$ is the classification index determined for the $i$-th environment and $k_i$ is a weighting factor assigned to the single environment (e.g. it can be equal to its surface, its volume, the number of people using it, etc.).

The values of the two indices can vary between 0 (if for the whole time of measurement all the parameters fall outside the limits of the III category) and 100 (if they lay within the limits of the I category). In particular, if all the parameters fall within the limits of the II category for the whole time of measurement, the value of the index is equal to 70, whereas, if they fall within the limits of the III category, the value is equal to 35.

Furthermore, on the basis of the values that the IQA and IQE indices can assume, the authors (Pietrafesa et al, 2008) achieve the definition of a scale with 7 values (Figure 4.2), which allows the determination of the quality class of the single environments or of the whole building.

**Figure 4.2: Quality classes of the indoor environments or the buildings depending on the values of the IQA and IQE indices.**

| Classe di qualità | IQA – IQE |
|---|---|
| A | 90 - 100 |
| B | 75 - 90 |
| C | 60 - 75 |
| D | 45 - 60 |
| E | 30 - 45 |
| F | 15 - 30 |
| G | 0 - 15 |

The quality categories of the indoor environments and the acceptable intervals for the parameters used to define the environmental quality categories are respectively reported in Table 4.5 and Table 4.6.

As it is clear, this second method, if from one side allows to label a whole building with an overall quality index, is strongly dependent on the weighting factors $p_i$, that, obviously, refer to the more general problem of the scarce knowledge about the reciprocal influence among the different spheres of the indoor performance. On the other hand, this framework allows the attribution of a relevant importance to the stakeholders. In every assessment process, it is advisable to assign to the stakeholders a diriment role concerning the preferences and priorities which are able to affect the evaluations.

**Table 4.5: Quality categories of the indoor environments**

| Category | Description |
|---|---|
| **I** | High level of comfort expectation, recommended for the spaces occupied by very sensitive and fragile people with particular needs (disabled people, children, elderly people, ill persons). |
| **II** | Normal level of comfort expectation, to be used for new buildings or refurbishments. |
| **III** | Acceptable, moderate level of comfort expectation, to be used for existing buildings. |
| **IV** | Levels of expectation that do nor fall within the previous categories, acceptable only for limited periods of the year. |

**Table 4.6: Acceptable intervals of variation for the parameters used to define the environmental quality categories**

| Parameter | Environmental quality category | | | |
|---|---|---|---|---|
| | **I** | **II** | **III** | **IV** |
| **Operative Temperature (°C) (heating period)** | 21.0-25.0 | 20.0-21.0<br>25.0-26.0 | 18.0-20.0<br>26.0-28.0 | <18.0<br>>28.0 |
| **Operative Temperature (°C) (cooling period)** | 23.5-25.5 | 23.0-23.5<br>25.5-26.0 | 22.0-23.0<br>26.0-27.0 | <22.0<br>>27.0 |
| **Air speed (m/s)** | <0.15 | 0.15-0.18 | 0.18-0.21 | >0.21 |
| **$CO_2$ concentration above the external concentration (ppm)** | <350 | 350-500 | 500-800 | >800 |
| **Lighting (lx)** | >750 | 500-750 | 300-500 | <300 |
| **Equivalent sound pressure level, Ponderation A (dB)** | <30 | 30-35 | 35-40 | >40 |

# 5. LCAs of buildings

This section examines the environmental impacts of building considering the whole cycle life. In order to illustrate these aspects we have reported some case studies. The aim is to provide an overview of all significant elements that characterise the environmental performance of building along own life cycle. Because of the difference construction practices and priority issue across Europe we have decided to select among the huge quantities of studies two representative projects. The first work presented is the result of a complex collaboration with different institutions such as the ENEA PROT-INN of Bologna, Universities and research institutions that have been collected case studies on LCA for several years from 1997 to 2006.

The main objective of this activity is to develop a sort of guidelines for a LCA approach to the sustainable design of buildings and the related database. This is a result of the integration of the different aspects belonging to different disciplines such as engineering, architecture, ecology, energy, environment, climate, etc. Aspects related to the life cycle of buildings from the winter and summer energy consumption to the material choice, production processes, energy contribution, transportation, emissions related to all the different phases).

The European project was developed by European thematic network PRESCO (Practical Recommendations for Sustainable Construction). The main objective of the PRESCO-network is to define a European Code of Practice for Sustainable Building. The Code contains widely accepted and scientifically supported guidance for the construction of sustainable buildings.

The project covers all phases of the life cycle of a building, going from inception and feasibility study through design and construction to use and refurbishment and finally to decommissioning, dismantling and disposal.

For the purposes of this document, we have decided to report only two significant cases concerning the LCA analysis for Italian houses.

## *5.1 THE EUROPEAN SCENARIO*

The Final Report of PRESCO reports the main results about pilot study buildings comparing different LCA tools for the assessment of the environmental performance.

The tools used in the study are the following:

- EQUER (ARMINES, France)
- ENVEST (BRE, United Kingdom)
- OGIP (EMPA, Switzerland)
- BeCost (VTT, Finland)
- ECO-QUANTUM (W/E Sustainable Building, The Netherlands)
- Eco-Soft (IBO, Austria))
- ESCALE (CSTB, France)
- SIMA-PRO (BDA Milieu, The Netherlands)
- LEGEP (ASCONA, Germany)

**EQUER** performs simulations of a building's life cycle in order to provide mechanical, energy and architectural engineers or architects with environmental indicators.

**Envest 2** (Envest upgraded version) explores ways of reducing a building's environmental impact at the design stage considering alternative options that can be weighed up until the optimum balance is reached.

**OGIP** is short for Optimisation of Global Demands in terms of costs, energy and environment within an Integrated Planning Process. OGIP allows to design the integral planning of buildings assessing the construction and operating costs, the grey energy of structure and the operating energy and providing a standardised method for calculating the environmental impact of the building's construction and operation.

**BeCost** furnishes a web-based tool for life cycle assessment of building structures and the whole building.

**Eco-Quantum** is a tool for the determination of the environmental performance of a building over its total span, with a calculation method based on LCA.

The main advantages of Eco-Quantum are that it is easy to use, it offers a wide variety of assessment methods, it is useful for target setting and is a useful decision support tool for designers and clients.

**Eco-Soft** is an LCA tool developed by IBO. It provides a wide variety of environmental indicators for the construction and the energy use of a building.

**ESCALE** offers the possibility to perform an iterative design process considering 11 main criteria.

Escale has two level of investigation: simplified and detailed.

**SimaPro** is a professional tool to collect, analyse and monitor the environmental performance of products and services following the ISO 14040 series recommendations.

**LEGEP** is a tool for integrated Life –cycle analysis. It is a useful support for the design, construction, quantity surveying and evaluation of new or existing buildings or building products. LEGEP is furnished of a detailed database for the assessment of a building.

The comparison of the tools was structured in three case studies:

- The first case study consisted in an analysis of a simple geometrical volume (Cube), with two main materials concrete and steel (reinforced concrete).
- The second was the assessment of a complete building (FUTURA house) in three different construction types (wooden, concrete or brick walls).
- The third consisted in applying some general recommendations for sustainable constructions from WP1 on the concrete type of the FUTURA house. The impact of each of these recommendations subsequently was investigated. The aim was a comparison of the sensitivity of the tools to some recommendations.

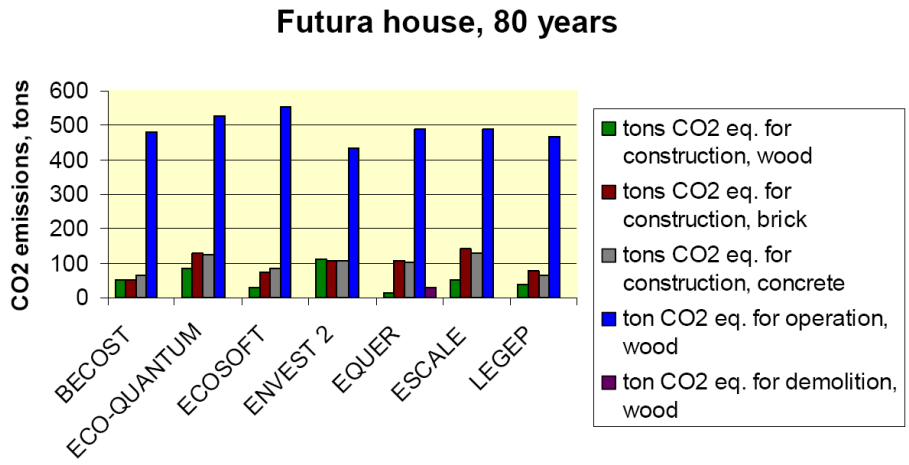
The most interesting part of this report is the environmental assessment of a complete building (FUTURA house). FUTURA house started as a Swiss demonstration project for low-energy, pre-fabricated wooden construction (figure 5.1).

**Figure 5.1 FUTURA house as a built**

FUTURA house is a single-family house with two levels (210 $m^2$ heated area), well insulated, with a high solar aperture. The energy for space heating and domestic hot water is gas, and the heating demand corresponds to a Swiss climate. The European electricity mix is considered. The analysis elaborated by the different tools developers took in account a life cycle assessment of 80 years operation period. Three different structural versions of FUTURE were studied, i.e. a wooden structure (comparable to "as built" house), a concrete structure and a brick masonry structure. The design of the building was adapted where necessary.

The results of analysis concerning the global warming indicator for the comparison between wood, brick and concrete structures is showed in figure below (figure 5.2).

**Figure 5.2: Building life cycle, comparison of wood brick and concrete alternatives**




Form the graph it is possible to individuate that the global warming indicator is lower for wood in all tools except ENVEST. Brick leads to higher emission according to 4 tools whereas the 3 other provide an opposite result, the difference between brick and concrete being small in all tools.

An overall view of the $CO_2$-Eq. Emissions shows for all the supremacy of the operation phase. Being very similar the emission during this phase, in the graph only the case of wood is reported.

Other indicators were analysed. The following graphs present these results for the whole life cycle in a first part (figure 5.3) and for all phases except operation (which is similar for the three alternatives compared; figure 5.4).

**Figure 5.3: Results of the different tools for three alternatives (wood, brick and concrete structure) over the whole life cycle**

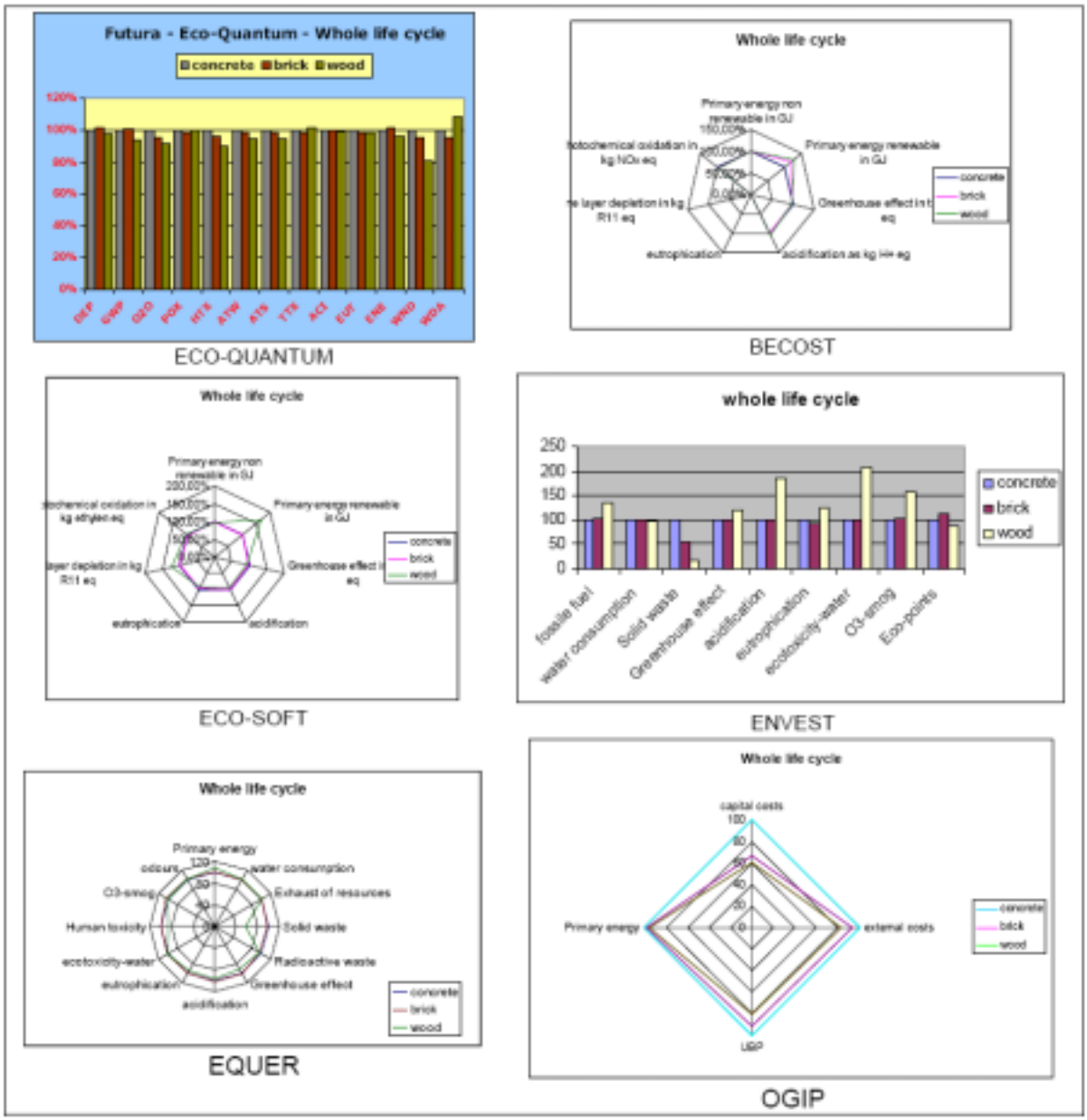
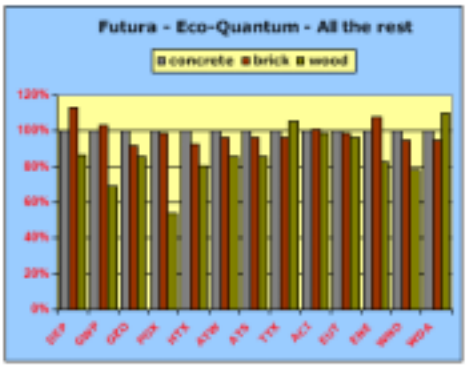
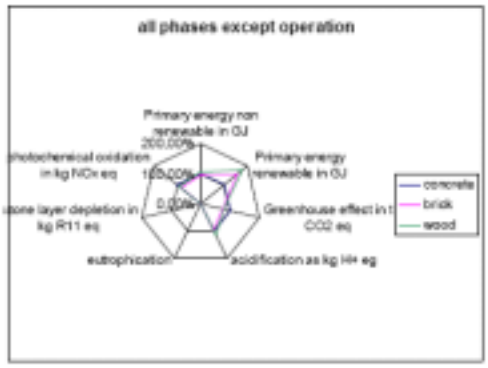


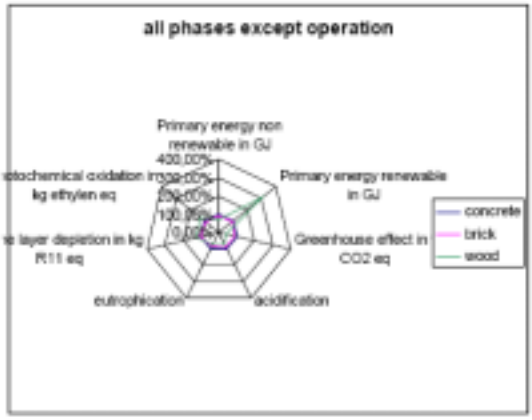
**Figure 5.4: Comparison of three alternatives (wood, brick and concrete structure) all phases except operation**



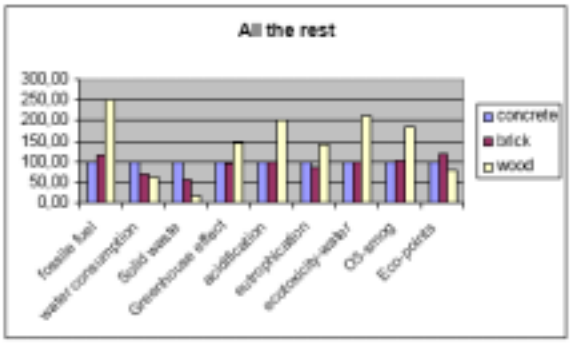

ECO-QUANTUM




BECOST

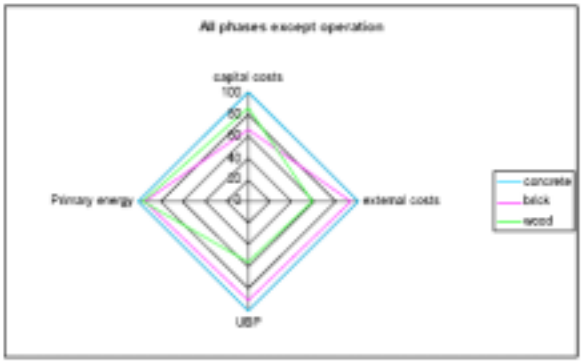



ECO-SOFT




ENVEST


EQUER




OGIP

In the conclusion of the report it is reported that the discrepancy in the results between the studied tools remained in a reasonable range (+/- 10%) concerning the global warming indicator. The authors furnish a long list of recommendations in order to improve the existing assessment tools Following sample shows some important ones:

- Try to have consistent LCI data with high transparency (same system boundary, clear allocation methods, no mixing of data from different sources, ect)
- If possible use up to date specific product LCI data with a clear user area
- Include all transports (also from upstream processes). If no data are available some country specific default value should be proposed.

- Proposed cut of rules: All in – and Output materials which have more than 2% mass of the end product must be included independent of environmental relevance. If the relevance can be proved also materials with less 2% mass must be taken into account.
- Account for both the use of recycled material in construction and recycling at the end of life in a consistent and transparent way.
- If possible include the land-use in the whole process from the cradle to gate.
- Include water consumption in the analysis although it is no indicator for environmental impact.
- The choice of the impact assessment indicators is arbitrary but needs explanation. Be careful using cumulated indicators as different environmental impacts are calculated into one value.
- Substitutions of certain materials/constructions must be taken into account after their service life. Be aware that a certain time before demolition no substitution will be made

In an outlook this study recommends, that further work is needed in harmonisation and facilitation of the building assessment tools. For the interpretation of the results the practitioner (architects, civil engineers, etc.) must be trained. Many of the tools must be much more transparent and easier to use.

## 5.2 SOME EXAMPLES OF THE ITALIAN SITUATION

This paragraph provides with examples of LCA for buildings in order to point out the major environmental impacts during the life cycle phases.

Below are reported the results from two different case studies:

- LCA of residential building of small dimensions in Bologna (Case IT/A);
- LCA of residential building of medium dimensions in Rome (Case IT/B)

The case studies are illustrated in table 5.1 e table 5.5 where are shown the boundary system, the impact evaluation system and the synthetic indicator used.

LCI data are reported in Annex 1.

It is also interesting to note the impact characterization table according to the Ecoindicator95 methods which points out the environmental impacts by means of the following impact indicators:

- greenhouse kg CO2
- ozone layer kg CFC11
- acidification kg SO2
- eutrophication kg PO4
- heavy metals kg Pb
- carcinogens kgB(a)P
- winter smog kg SPM
- summer smog kg C2H4
- energy resources MJ LHV
- solid waste kg

The Ecoindicator95 system is based on classic impact indicators used in the LCA methodology.

Nevertheless in the case study examined the LCA results are expressed by means of another impact evaluation method such as the Ecoindicator99 system based on a set of indicators slightly different.

The results are therefore expressed according to the Ecoindicator99 system by means of a final score system, so called Ecopoint, which synthesizes the environmental impacts of a particular phase and/or of the all life cycle.

### 5.2.1 A residential building in Bologna (IT) – Case IT/A

Main objective of the study, synthetically presented, is to evaluate environmental impacts coming from production, use and end of life of a two floor building with four flats. In particular the study investigates possible environmental and economical improvements derived from changes in building phases and in the use phase of the building itself (heating and lighting of flats).

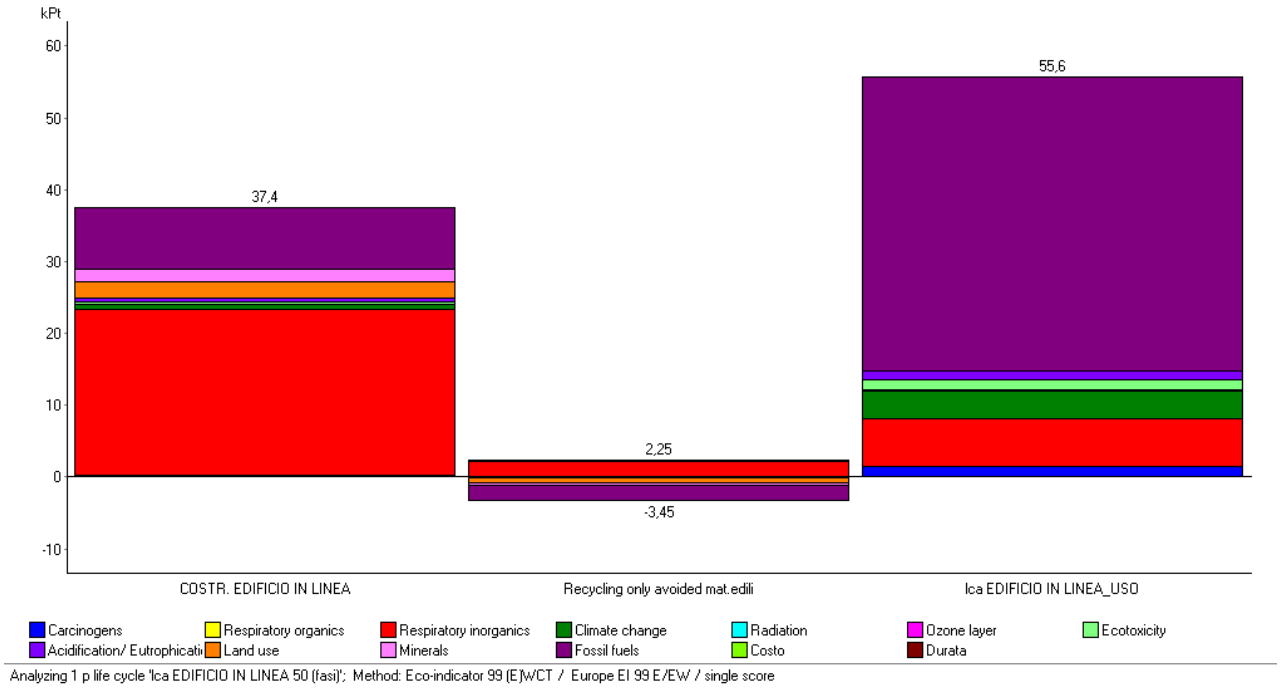
**Table 5.1: Basis data of the LCA of case IT/A**

| CASE STUDY | Building |
|---|---|
| Building type | Residential (medium size) |
| Title of the study | "Ecodesign di una superficie in linea" |
| Site | Molinella (BO) |
| Year | 2002 |
| Land occupation | 287m2*50 years |
| Functional unit | All components of the building |
| System boundaries | From extraction of raw materials, use phase and EoL. |
| Details | 2 floors, 4 apartments |
| Life (estimate) | 50 |
| Authors | Francesca Bianconi-Paolo Neri |
| Document | Doc ENEA - PROT – P135 - 001 e "Verso la certificazione degli edifici"- Alinea Editrice |
| Certification | NO |
| Data from | Cooperativa C.O.P.A.L.C. - Bologna |
| Evaluation method | Eco-indicator 99 modified |
| Indicator | Ecopoint |
| Software used | SimaPro5 (Product stages) |

**Table 5.2: Characterisation table of case IT/A according to Ecoindicator95 method**

| Environmental impact | u.m. eq. | Construction | Use | End of life | Total |
|---|---|---|---|---|---|
| greenhouse | kg CO2 | 2,080E+05 | 9,350E+05 | -4,520E+04 | 1,100E+06 |
| ozone layer | kg CFC11 | 5,810E-02 | 3,320E-01 | -1,140E-02 | 3,790E-01 |
| acidification | kg SO2 | 1,520E+03 | 4,460E+03 | -1,990E+02 | 5,780E+03 |
| eutrophication | kg PO4 | 1,050E+02 | 1,940E+02 | -1,620E+01 | 2,830E+02 |
| heavy metals | kg Pb | 1,250E+00 | 3,060E+00 | -8,450E-03 | 4,300E+00 |
| carcinogens | kgB(a)P | 2,980E-02 | 5,610E-02 | -1,670E-02 | 6,920E-02 |
| winter smog | kg SPM | 1,030E+04 | 3,440E+03 | 1,070E+03 | 1,480E+04 |
| summer smog | kg C2H4 | 1,680E+02 | 3,550E+02 | -2,670E+01 | 4,970E+02 |
| energy resources | MJ LHV | 3,310E+06 | 1,600E+07 | -7,740E+05 | 1,850E+07 |
| solid waste | kg | 4,720E+04 | | -1,190E+06 | -1,150E+06 |

**Figure 5.5: LCA of case IT/A – Ecopoints according to the Ecoindicator 99 method.**




The analysis carried out and synthetically reported in the above figure shows that manly environmental impacts come from the building's use phase (the 60,5%); therefore it seams appropriate to focus attention for modification and improvements of environmental performances related to the use phase.

The construction phase is responsible for about 40,7% of the whole environmental impacts and simulation carried out by the substitution of traditional construction materials with better environmental performance materials, shows very little environmental performance improvements both in the construction and in the use phase. Despite the study shows that the main environmental performance improvements come from interventions on the energy consumptions, it also underlines the importance of using eco-materials such as cork and sawdust, which are materials with very good igro - thermic and environmental performances.

Building's energy performances have been evaluated also simulating the use of solar collector for water heating, the use of low emissions condensing boiler and the installation of radiating panel instead of normal radiators.

Some others environmental improvements come from the recycling of demolition material, during the end of life phase, and their re-use for street construction and as filler.

### 5.2.2 A residential building in Roma – Case IT/B

Study objectives are synthetically reported as:

1. The assessment of environmental and energy impacts and the economic evaluation for a residential unit (with life expected of about 100 years);
2. the assessment of environmental performance improvements coming from the modification of the building's envelope and plants, and the adjustments in order to respect the energy efficiency regulations (UE 2002/91 CE, Italian D.L. 192/05).

Trough the LCA methodology the study has:

- Quantified the environmental damage of a unitary standard sample for a residential flat;
- Reduced the environmental impacts up to the 40% through new project's hypothesis for materials and plants.

The hypothesis for the environmental performance improvements have been addressed into modification for:

- The building's envelope;
- The heating and electric plants.

In detail, with reference to the basis case, there have been simulated the following two hypotheses:

1st) new kind of envelope for walls and roof, heating pump;

2nd) new kind of envelope for walls, ventilated roof with cellulose fibres as insulating material, heating pump, photovoltaic panels and solar collectors.

**Table 5.3: Basis data of the LCA of case IT/B**

| **CASE STUDY** | **Building** |
|---|---|
| Building type | Residential (large size) |
| Title of the study | |
| Site | Roma |
| Land occupation | 55.83m2*100 years |
| Functional unit | An apartment |
| System boundaries | From extraction of raw materials, use phase and EoL. |
| Details | 3296.4047m2/59.04=55.83m2 |
| Life (estimate) | 100 years |
| Authors | Chiara Zevi-Paolo Neri |
| Years | 2006 |
| Document | doc ENEA - PROT – P135 – 099 e 'Verso la certificazione degli edifici"- Alinea Editrice |
| Certification | NO |
| Data from | Project |
| Software used | SimaPro6 |
| Evaluation method | Eco-indicator 99 modified |
| Indicator | Ecopoints |
| Objective of the study | Comparison between a classical approach and a solution with lower energy consumption for winter and summer conditioning and lower non renewable energy consumption. (BASE CASE – LOW ENERGY CASE) |

**Table 5.4: Characterisation table of case IT/B according to Ecoindicator95 method**

| Environmental effect | u.m. eq. | Construction and End of Life | Maintenance | Use phase | Total |
|---|---|---|---|---|---|
| greenhouse | kg CO2 | 2,990E+04 | 6,030E+03 | 3,430E+05 | 3,750E+05 |
| ozone layer | kg CFC11 | 1,280E-02 | 4,800E-03 | 1,290E-01 | 1,470E-01 |
| acidification | kg SO2 | 1,880E+02 | 2,850E+01 | 1,240E+03 | 1,630E+03 |
| eutrophication | kg PO4 | 2,280E+01 | 5,020E+00 | 7,960E+01 | 1,070E+02 |
| heavy metals | kg Pb | 2,361E-02 | 2,690E-01 | 1,260E+00 | 1,870E+00 |
| carcinogens | kg B(a)P | 5,520E-03 | 1,490E-03 | 1,660E-02 | 2,360E-02 |
| winter smog | kg SPM | 5,400E+02 | 2,730E+01 | 8,520E+02 | 1,420E+03 |
| summer smog | kg C2H4 | 2,250E+01 | 6,580E+00 | 8,490E+01 | 1,140E+02 |
| energy resources | MJ LHV | 4,210E+05 | 7,990E+04 | 4,270E+06 | 4,770E+06 |
| solid waste | kg | -1,410E+04 | -1,160E+04 | 0,000E+00 | -2,570E+04 |

**Figure 5.6: LCA of case IT/B-Basis case – Ecopoints according to the Ecoindicator 99 method.**

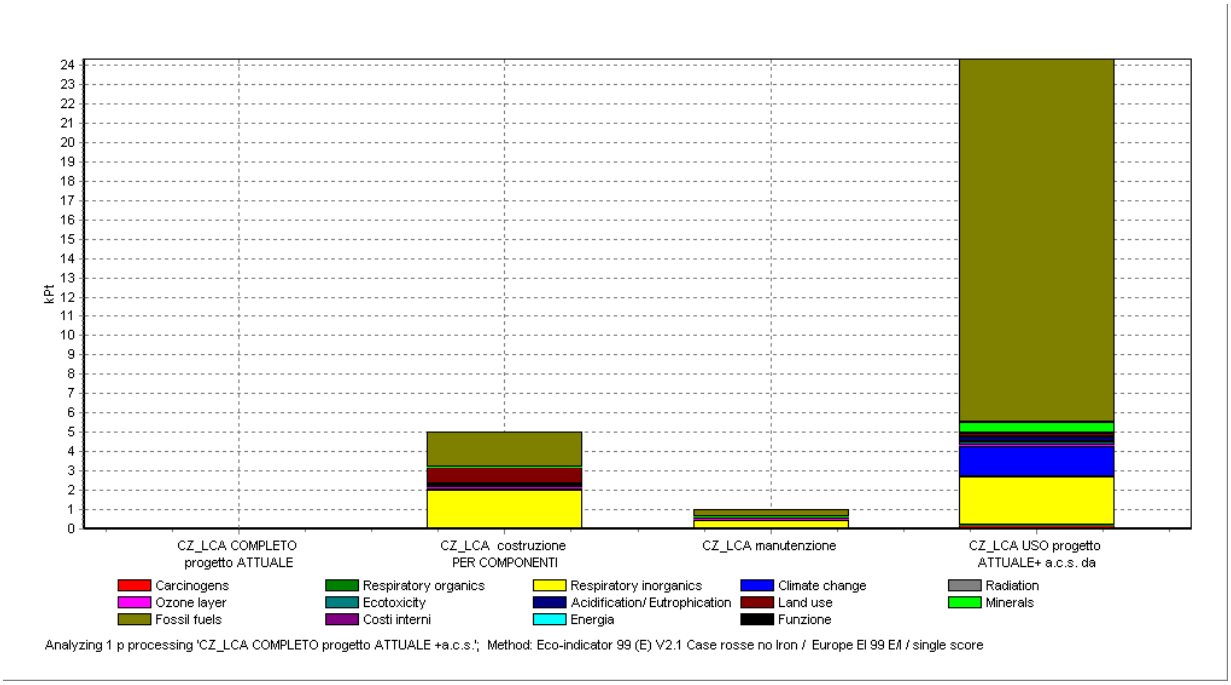


**Figure 5.7: Figure 5.8: LCA of case IT/B-Low energy case – Ecopoints according to the Ecoindicator 99 method.**

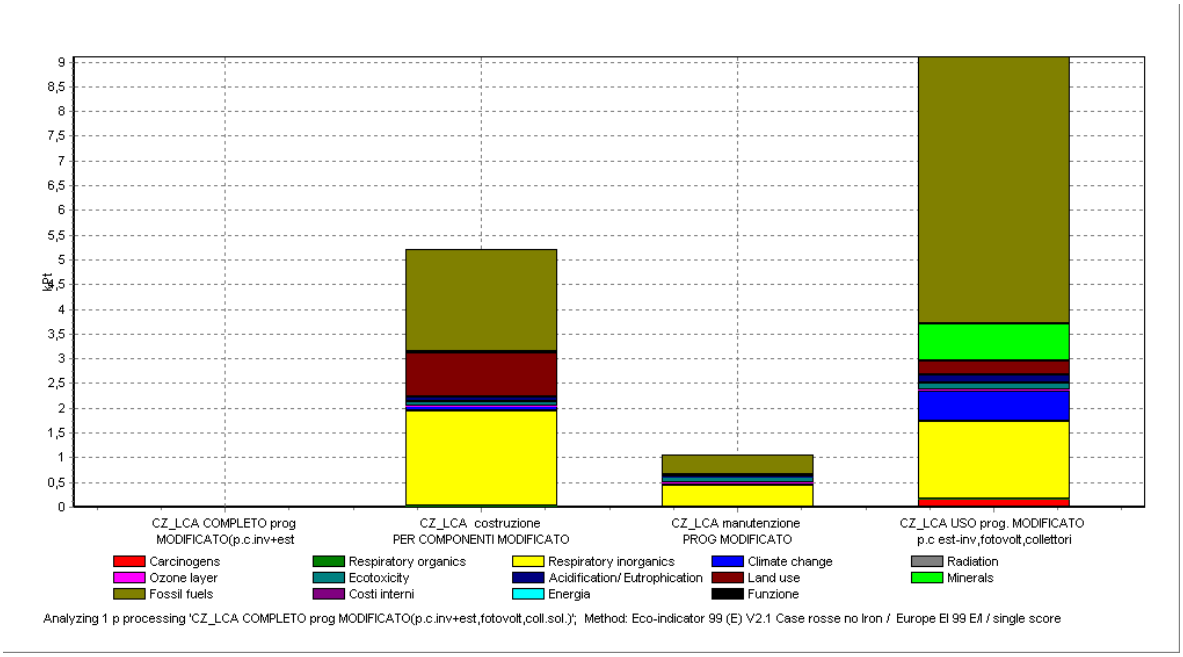
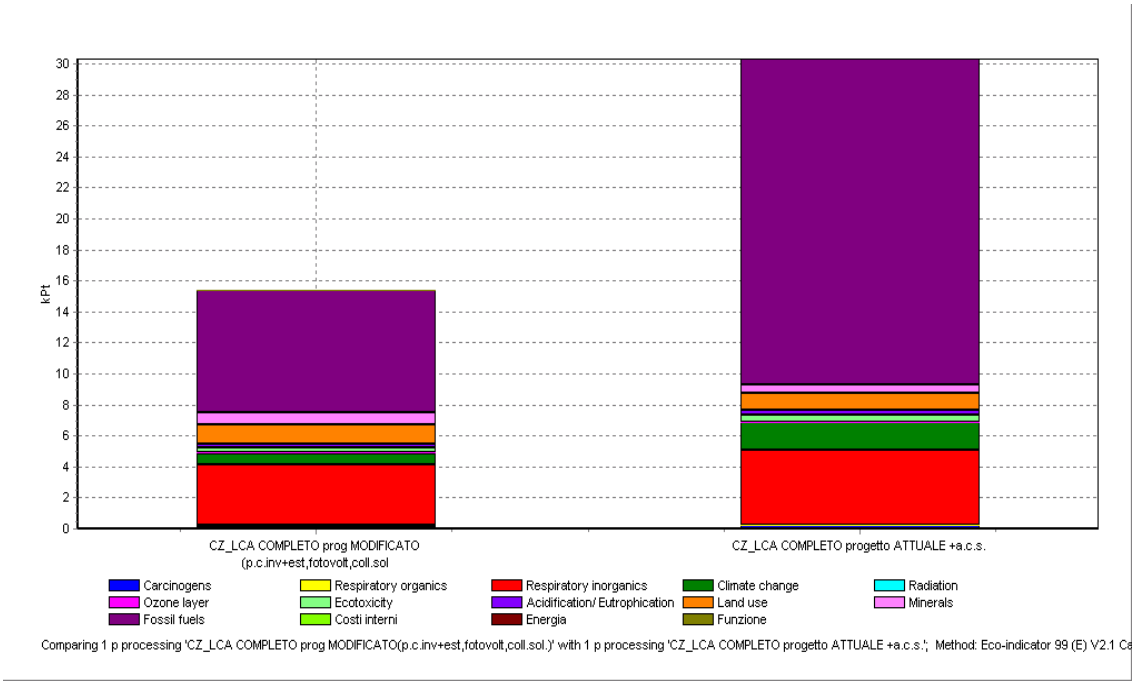



**Figure 5.9: Comparison between LCAs of case IT/B Base case vs Low energy case – Ecopoints according to the Ecoindicator 99 method.**



The study has underlined the considerable advantages coming from the two simulated hypothesis; in the 1st hypothesis, the environmental impacts have been reduced about 15% while in the 2nd hypothesis about the 43%.

The study has even underlined the costs for the realisation of the two hypothesis interventions. Costs for interventions related to the 1st hypothesis are slightly higher than the ones in the basis case; related costs for the 2nd hypothesis are much higher than the ones in basis case, but there are counterbalanced during the building's use phase (for 100 years life of building).

# 6. Existing criteria

## 6.1 INTRODUCTION

In this chapter an analysis of existing Ecolabel schemes has been carried out with special attention to those initiatives focusing to residential buildings.

The objective was to identify three main aspects:

- Main issues mostly present in the certification schemes analysed;
- Mandatory requirements mostly used;
- Type of requirements such as on-off or point score.

It is important to underline that Ecolabel schemes analysed are not comparable to each other as they are using different assessment methodologies and criteria are addressed to specific life cycle phases.

Nevertheless, the analysis allows pointing out the most important areas where the most relevant issues insist and therefore useful element to be considered within European Ecolabel criteria development methodology.

Beside the analysis of existing criteria of Ecolabel schemes other European initiatives have been considered such as CEN/TC 350 standards, the CPR proposal and GPP criteria.

Those further initiatives have been included in order to consider the environmental indicators already identified in order to guarantee synergies and integration amongst the existing initiatives.

The chapter provides the list of criteria examined where are pointed out the type or requirements (on-off or point score) and if mandatory. For a comprehensive description of each single certification schemes see the Preliminary report.

## 6.2 THE CEN/TC350 INDICATORS

The CEN/TC 350 is currently working on the development of European horizontal standards for sustainability assessment of buildings.

Sustainability assessment with the performance based approach in terms of:

- Environmental performance
- Social performance
- Economic performance

Focal points of CEN/TC 350 activities are:

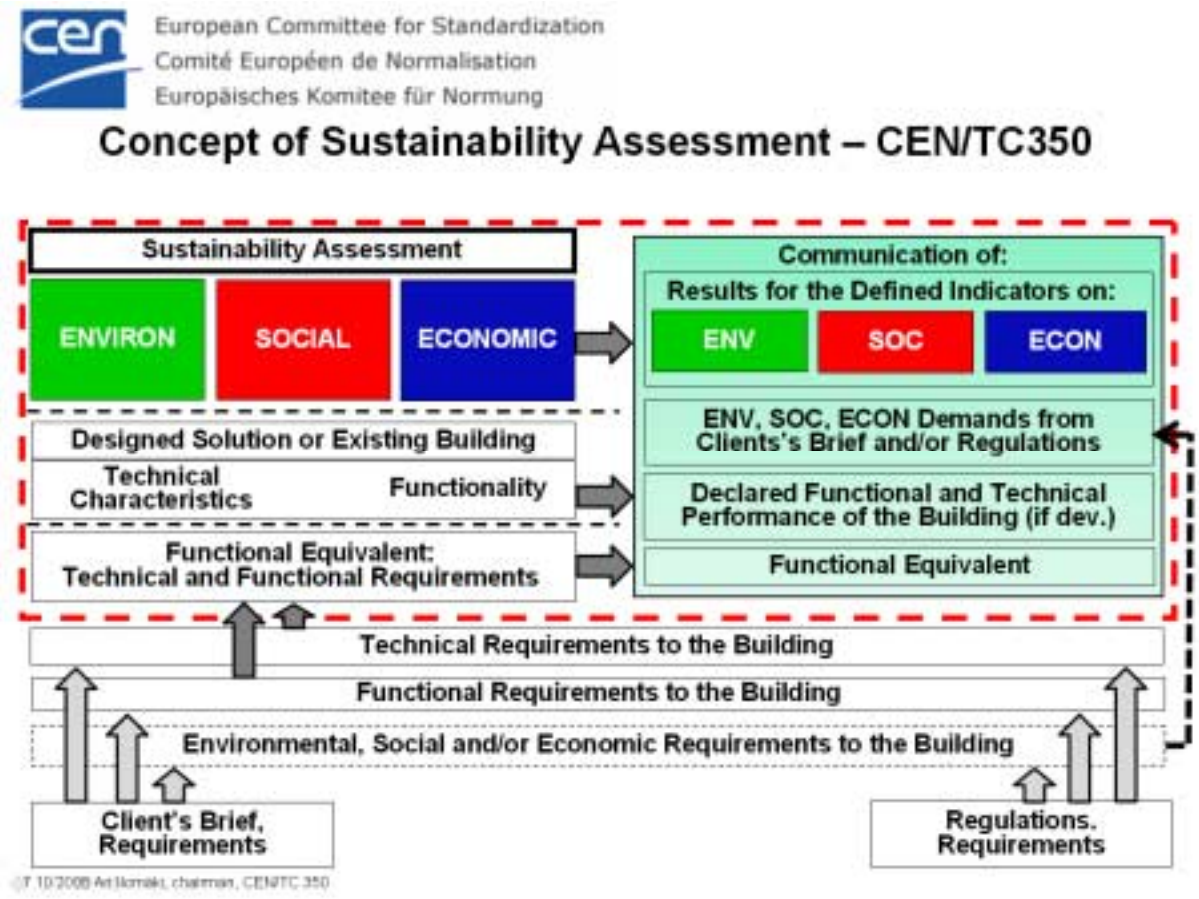
- a life cycle approach with quantitative indicators;
- wishes/needs of the relevant policies of the European Commission related to the construction products (Construction Products Regulation, Eco-design, Greening Public Procurement, Energy-label, Eco-label, Lead Market Initiative, European Platform on LCA);
- prevention of potential technical trade barriers, internal and international market (linking harmonized EPD to the CE-marking);

- International framework of ISO standards of ISO/TC59/SC17 (Building Construction – Sustainability in Building Construction).

The following figure shows the concept of sustainability in CEN TC 350. It has to be noted, in relation with developing Ecolabel criteria for buildings, that the CEN/TC 350 working group has defined (or is defining) set of indicators for the 3 sustainability aspects such as:

- Environmental performance topic comprises only "Ecology" indicators for buildings;
- Social performance topic comprises Health and Comfort indicators for buildings.

**Figure 6.1: The concept of sustainability assessment according to the CEN/TC 350**

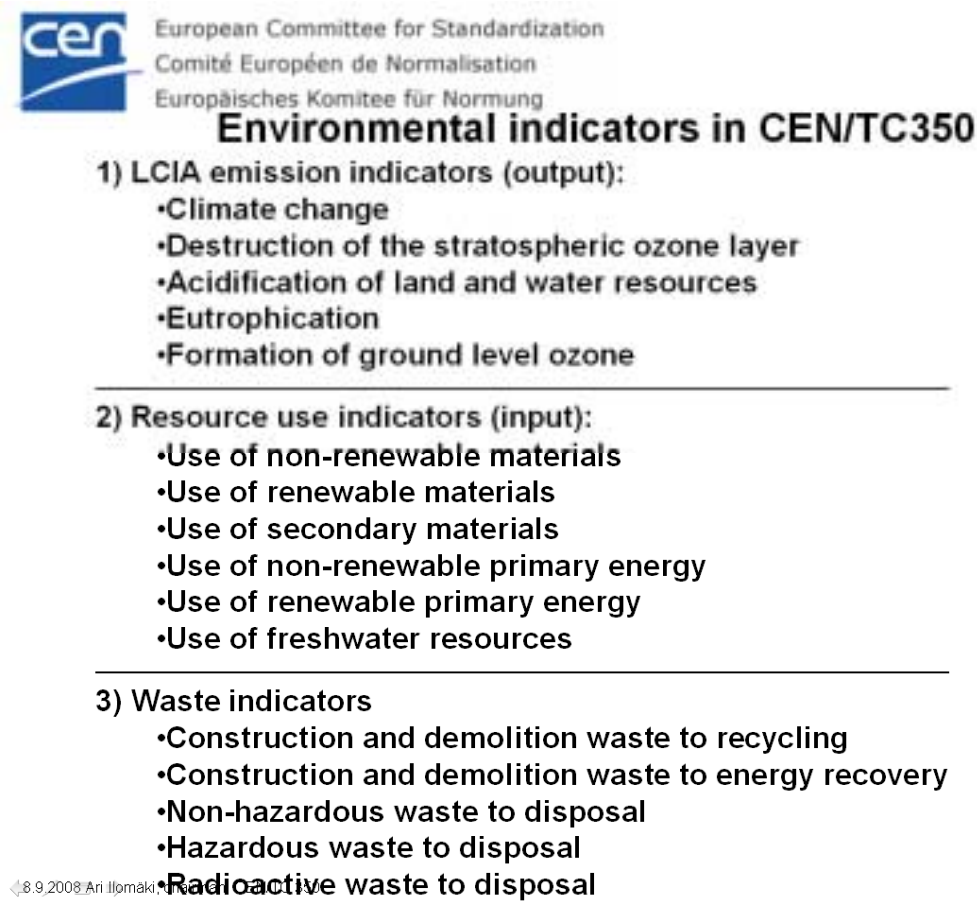



**Source: Ari Ilomäki, chairman, CEN/TC 350**

It is interesting to underline environmental indicators chosen by CEN/TC 350 because of the connection with Building's European Ecolabel related aspects.

The following box shows the environmental indicators according to CEN/TC 350.

**Figure 6.2: Proposal of the environmental indicators in CEN/TC 350**




**Source: Ari Ilomäki, chairman, CEN/TC 350**

Some of the CEN/TC350 proposed indicators could be taken as indicators also for the European Ecolabel criteria. The main objective is to make them comparable for the two different instruments, the Ecolabel and the Technical norms proposed by CEN.

## *6.3 THE CONSTRUCTION PRODUCTS DIRECTIVE (CPD)*

The European Commission revised the Construction Products Directive (89/106/EEC)and proposed to replace it by a Regulation (Regulation of the European Parliament and of the Council laying down harmonised conditions for the marketing of the Construction Products) and make its implementation easier by providing some simplified mechanisms.

The objective of the Construction Products Directive (89/106/EEC)1, referred to hereafter as the CPD, is to ensure free circulation and use of construction products in the internal market.

While, in short, the objective of the Regulation is not to define the safety of the products, but to ensure that reliable information is presented in relation to their performances. This is achieved by providing a common technical language to be used by manufacturers when placing products on the market and by public authorities when defining the technical requirements of works which influence, either directly or indirectly, the products to be used in those works.

The point 1 of the Article 3 (Basic works requirements and essential product characteristics) of the CPR establishes that "The essential characteristics of construction products shall be laid down in harmonised technical specifications in relation to the basic works requirements which are set out in Annex I.

The Annex I of the CPR (see following figure) establishing basic work requirements, concerns in particular also environmental, health and safety topics which are connected to Ecolabel approach.

## CPD – ANNEX 1

### art. 3. HYGIENE, HEALTH AND THE ENVIRONMENT

The construction works must be designed and built in such a way that they will not be a threat neither to the hygiene nor health of the occupants and neighbours, nor exert a exceedingly high impact over their entire life cycle to the environmental quality nor to the climate, during their construction, use and demolition, in particular as a result of any of the following:

(a) the giving-off of toxic gas;

(b) the emissions of dangerous substances, volatile organic compounds (VOC), greenhouse gases or dangerous particles into indoor or out door air;

(c) the emission of dangerous radiation;

(d) the release of dangerous substances into drinking water, ground water, marine waters or soil;

(e) faulty discharge of waste water, emission of flue gases or faulty disposal of solid or liquid wastes;

(f) the presence of dampness in parts of the works or on surfaces within the works.

### Art. 5. PROTECTION AGAINST NOISE

The construction works must be designed and built in such a way that noise perceived by the occupants or people nearby is kept down to a level that will not threaten their health and will allow them to sleep, rest and work in satisfactory conditions.

### Art. 6. ENERGY ECONOMY AND HEAT RETENTION

The construction works and their heating, cooling and ventilation installations must be designed and built in such a way that the amount of energy required in use shall be low, when account is taken of the climatic conditions of the location and the occupants.

### Art. 7. SUSTAINABLE USE OF NATURAL RESOURCES (new CPR element)

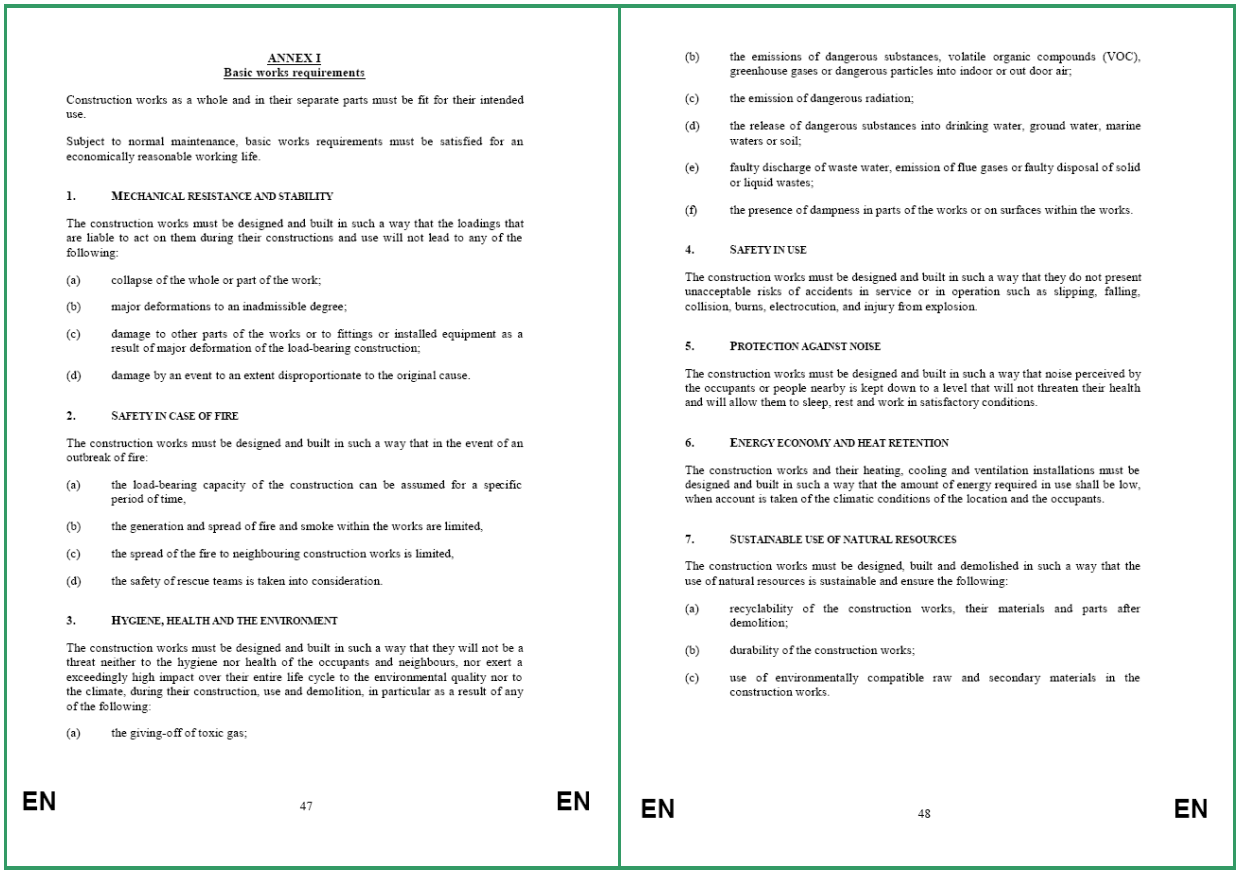
The construction works must be designed, built and demolished in such a way that the use of natural resources is sustainable and ensure the following:

(a) recyclability of the construction works, their materials and parts after demolition;

(b) durability of the construction works;

(c) use of environmentally compatible raw and secondary materials in the construction works.

**Figure 6.3: The ANNEX I of the CPR**



ANNEX I
Basic works requirements

Construction works as a whole and in their separate parts must be fit for their intended use.

Subject to normal maintenance, basic works requirements must be satisfied for an economically reasonable working life.

1. MECHANICAL RESISTANCE AND STABILITY

The construction works must be designed and built in such a way that the loadings that are liable to act on them during their constructions and use will not lead to any of the following:

(a) collapse of the whole or part of the work;

(b) major deformations to an inadmissible degree;

(c) damage to other parts of the works or to fittings or installed equipment as a result of major deformation of the load-bearing construction;

(d) damage by an event to an extent disproportionate to the original cause.

2. SAFETY IN CASE OF FIRE

The construction works must be designed and built in such a way that in the event of an outbreak of fire:

(a) the load-bearing capacity of the construction can be assumed for a specific period of time,

(b) the generation and spread of fire and smoke within the works are limited,

(c) the spread of the fire to neighbouring construction works is limited,

(d) the safety of rescue teams is taken into consideration.

3. HYGIENE, HEALTH AND THE ENVIRONMENT

The construction works must be designed and built in such a way that they will not be a threat neither to the hygiene nor health of the occupants and neighbours, nor exert a exceedingly high impact over their entire life cycle to the environmental quality nor to the climate, during their construction, use and demolition, in particular as a result of any of the following:

(a) the giving-off of toxic gas;

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(b) the emissions of dangerous substances, volatile organic compounds (VOC), greenhouse gases or dangerous particles into indoor or out door air;

(c) the emission of dangerous radiation;

(d) the release of dangerous substances into drinking water, ground water, marine waters or soil;

(e) faulty discharge of waste water, emission of flue gases or faulty disposal of solid or liquid wastes;

(f) the presence of dampness in parts of the works or on surfaces within the works.

4. SAFETY IN USE

The construction works must be designed and built in such a way that they do not present unacceptable risks of accidents in service or in operation such as slipping, falling, collision, burns, electrocution, and injury from explosion.

5. PROTECTION AGAINST NOISE

The construction works must be designed and built in such a way that noise perceived by the occupants or people nearby is kept down to a level that will not threaten their health and will allow them to sleep, rest and work in satisfactory conditions.

6. ENERGY ECONOMY AND HEAT RETENTION

The construction works and their heating, cooling and ventilation installations must be designed and built in such a way that the amount of energy required in use shall be low, when account is taken of the climatic conditions of the location and the occupants.

7. SUSTAINABLE USE OF NATURAL RESOURCES

The construction works must be designed, built and demolished in such a way that the use of natural resources is sustainable and ensure the following:

(a) recyclability of the construction works, their materials and parts after demolition;

(b) durability of the construction works;

(c) use of environmentally compatible raw and secondary materials in the construction works.

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## *6.4 INTERNATIONAL CRITERIA*

### 6.4.1 The iiSBE International

| AWARD | |
|---|---|
| Name | iiSBE International (SBTool) |
| Type | Rating |
| Author | International initiative for a Sustainable Built Environment |
| geographic area | international |

**Table 6.1: The main issues taken into account by the iiSBE criteria**

| CRITERIA |
|---|
| A - SITE SELECTION, PROJECT PLANNING AND DEVELOPMENT |
| A1 - Site Selection |
| A2 - Project Planning |
| A3 - Urban Design and Site Development |
| B - ENERGY AND RESOURCE CONSUMPTION |
| B1 - Total Life Cycle Non-Renewable Energy |
| B2 - Electrical peak bdemand for facility operations |
| B3 - Renewable Energy |
| B4 - Materials |
| B5 - Potable Water |
| C - ENVIRONMENTAL LOADINGS |
| C1 - Greenhouse Gas Emissions |
| C2 - Other Atmospheric Emissions |
| C3 - Solid Wastes |
| C4 - Rainwater, Stormwater and Wastewater |
| C5 - Impacts on Site |
| C6 - Other Local and Regional Impacts |
| D - Indoor Environmental Quality |
| D1 - Indoor Air Quality |
| D2 - Ventilation |
| D3 - Air Temperature and Relative Humidity |
| D4 - Daylighting and Illumination |
| D5 - Noise and Acoustics |
| E - Service Quality |
| E1 - Safety and Security During Operations |
| E2 - Functionality and efficiency |
| E3 - Controllability |
| E4 - Flexibility and Adaptability |
| E5 - Commissioning of facility systems |
| E6 - Maintenance of Operating Performance |
| F - Social and Economic aspects |
| F1 - Social Aspects |
| F2 - Cost and Economics |
| G - Cultural and Perceptual Aspects |
| G1 - Culture & Heritage |
| G2 – Perceptual Aspects |

### 6.4.2 The LEED rating system

| STANDARD | |
|---|---|
| Standard name | **LEED Rating Systems** |
| Type | rating |
| Author | USGBC |
| Geographical area | USA |
| Self declaration standard | no |
| Standard with third part verification | yes |
| Criteria | Version 2005 |

| STANDARD addressed to | Project | Construction | Use and maintenance | Refurbishment | End of Life |
|---|---|---|---|---|---|
| Private and social housing schemes<br>Flats/apartments and houses<br>New build and major refurbishment | x | x | x | x | |

**Table 6.2: The main issues taken into account by the LEED for homes criteria**

| |
|---|
| **Sustainable Sites** |
| **Water Efficiency** |
| **Energy & Atmosphere** |
| **Materials & Resources** |
| **Indoor Environmental Quality** |
| **Innovation in Operations** |

### 6.4.3 The CASBEE – Japanese system

**Table 6.3: The main issues taken into account by the CASBEE for Home (Detached House) (2007 edition) criteria**

| | |
|---|---|
| QH | Environmental Quality of the Building |
| QH1 | Comfortable, Healthy and Safe Indoor Environment |
| 1 | Heating and Cooling |
| 2 | Health, Safety and Security |
| 3 | Brightness |
| 4 | Quietness |
| QH2 | Ensuring a Long Service Life |
| 1 | Basic Life Performance |
| 2 | Maintenance |
| 3 | Functionality |
| QH3 | Creating a Richer Townscape and Ecosystem |
| 1 | Consideration of the Townscape and Landscape |
| 2 | Creating the Biological Environment |
| 3 | Safety and Security of the Region |
| 4 | Utilizing Regional Resources and Inheriting the Regional Housing Culture |
| LRH | Environmental Load Reduction of the Building |
| LRH1 | Conserving Energy and Water |
| 1 | Energy Saving through Building Innovation |
| 2 | Energy Saving through Equipment Performance |
| 3 | Water Conservation |
| 4 | Well-Informed Maintenance and Operation Schemes |
| LRH2 | Using Resources Sparingly and Reducing Waste |
| 1 | Introduction of Materials Useful for Resource Saving and Waste Prevention |
| 2 | Reduction of Waste in the Production and Construction Stages |
| 3 | Promotion of Recycling |
| LRH3 | Consideration of the Global, Local and Surrounding Environment |
| 1 | Consideration of Global Warming |
| 2 | Consideration of the Local Environment |
| 3 | Consideration of the Surrounding Environment |

## 6.5 EUROPEAN CRITERIA

### 6.5.1 The Code for Sustainable Homes - UK

| STANDARD | |
|---|---|
| Standard name | **Code for Sustainable Homes** |
| Type | Rating |
| Author | BRE |
| Geographical area | UK |
| Self declaration standard | no |
| Standard with third part verification | yes |
| Criteria | Version February 2008 |

| STANDARD addressed to | Project | Construction | Use and maintenance | Refurbishment | End of Life |
|---|---|---|---|---|---|
| Private and social housing schemes<br>Flats/apartments and houses<br>New build and major refurbishment | x | x | x | X | |

**Table 6.4: The main issues taken into account by the Code for Sustainable Homes**

| Categories |
|---|
| Energy and $CO_2$ emissions |
| Water |
| Materials |
| Surface water run-off |
| Waste |
| Pollution |
| Health and wellbeing |
| Management |
| Ecology |

### 6.5.2 The Swan-labelling of Small houses

| STANDARD | |
|---|---|
| Standard name | **Swan-labelling of Small houses** |
| Type | hurdle |
| Author | Nordic Ecolabelling |
| Geographical area | Denmark, Norway, Iceland, Sweden, Finland |
| Self declaration standard | no |
| Standard with third part verification | yes |
| Criteria | Version 1.5 15/3/05 - 31/3/10 |

| STANDARD addressed to | Project | Construction | Use and maintenance | Refurbishment | End of life |
|---|---|---|---|---|---|
| Small houses | x | x | x | | |

**Table 6.5: The main issues taken into account by the Swan-labelling of Small houses criteria**

| |
|---|
| General description of the house |
| Responsibility of the building process |
| Energy and ventilation |
| Material requirements |
| Quality management and control for the building process |
| Instructions for residents |

### 6.5.3 The Haute Qualité Environnementale

**Table 6.6: The main issues taken into account by the HQE criteria**

| |
|---|
| Ecoconstruction |
| Ecogestion |
| Création d'un environnement intérieur satisfaisant |
| Santé |

### 6.5.4 The klima:aktiv

| STANDARD | |
|---|---|
| Standard name | **klima:aktiv** |
| Type | rating |
| Author | Österreichische Gesellschaft für Umwelt und Technik - ÖGUT |
| Geographical area | Austria |
| Self declaration standard | no |
| Standard with third part verification | yes |
| Criteria | Version 3.3.4<br>18 Januar 2008 |

| STANDARD addressed to | Project | Construction | Use and maintenance | Refurbishment | End of life |
|---|---|---|---|---|---|
| new-built residential buildings (both single family houses and multi-storey houses) | x | x | x | | |

**Table 6.7: The main issues taken into account by the klima:aktiv criteria**

| |
|---|
| Design and Execution |
| Design |
| Execution |
| Energy and Supply |
| Heat demand and supply |
| Energy demand (electrical) |
| Water demand |
| Materials and Construction |
| Materials |
| Construction and Building |
| Comfort and Indoor Air-quality |
| Thermal Comfort |
| Indoor Air-quality |

### 6.5.5 The ITACA protocol

| STANDARD | |
|---|---|
| Standard name | PROTOCOLLO ITACA |
| Type | Rating |
| Author | ITACA - IT |
| Geographical area | Italy |
| Self declaration standard | Yes |
| Standard with third part verification | |
| Criteria | |

| STANDARD addressed to | Project | Construction | Use and maintenance | Refurbish. | End of Life |
|---|---|---|---|---|---|
| | X | X | X | | |

**Table 6.8: The main issues taken into account by the ITACA criteria**

| CRITERIA |
|---|
| 1- Outdoor environmental quality |
| 1.1 - outdoor environmental comfort |
| 1.2 - local pollution |
| 1.3 context integration |
| 2- Resource consumption |
| 2.1- energy consumption |
| 2.2- soil consumption and impact on ecologic quality |
| 2.3- potable water consumption |
| 2.4- materials consumption |
| 3- environmental charge |
| 3.1- gas emission reduction |
| 3.2- liquid wastes reduction |
| 3.3- solid built waste management |
| 3.4- waste management |
| 3.5- impacts on site |
| 4- indoor air quality |
| 4.1 - visual comfort |
| 4.2- acoustic comfort |
| 4.3- heat comfort |
| 4.4- air quality |
| 5- service quality |

| |
|---|
| **5.1- built and plan design maintenance** |
| **5.2- consumptions monitoring** |
| **5.3- common areas** |
| **5.4- live space quality** |
| **6- management quality** |
| **6.1- technical documentation of the building** |
| **6.2- use manual** |
| **6.3- programmed maintenance** |
| **6.4- building security** |
| **7- transport** |
| **7.1- public transport integration** |
| **7.2- measure to implement alternative transport** |
| **7.3- proximity to local services** |

### 6.5.6 The SB100 standard

| **STANDARD** | |
|---|---|
| Standard name | SB100 |
| Type | rating |
| Author | ANAB |
| Geographical area | Italy |
| Self declaration standard | no |
| Standard with third part verification | yes |
| Criteria | |

| **STANDARD addressed to** | **Project** | **Construction** | **Use and maintenance** | **Refurbishment** | **End of Life** |
|---|---|---|---|---|---|
| Public buildings | x | x | x | x | |
| Residential buildings | x | x | x | x | |
| Offices | x | x | x | x | |
| Other buildings (productive sites) | x | x | x | x | |

**Table 6.9: The main issues taken into account by the SB100 standard**

| CRITERIA | Type of requirement | |
|---|---|---|
| ECOLOGY | on/off | rating |
| 1. Energy | | |
| 2 WATER | | |
| 3. MATERIALS | | |
| 4. WASTE | | |
| SOCIETY | | |
| 1. HEALTH | | |
| 2. Comfort | | |
| 3. Contest | | |
| ECONOMY | | |
| 1. Info | | |
| 2. Costs | | |
| 3. Management | | |

### 6.5.7 The LEnSE project

| STANDARD | |
|---|---|
| Standard name | LEnSE project |
| Type | Rating |
| Author | Belgian Building Research Institute |
| Geographical area | |
| Self declaration standard | no |
| Standard with third part verification | yes |
| Criteria | |

| STANDARD addressed to | Project | Construction | Use and maintenance | Refurbish. | End of Life |
|---|---|---|---|---|---|
| Public buildings | x | x | x | x | |
| Residential buildings | x | x | x | x | |

**Table 6.10: The main issues taken into account by the LEnSE project criteria**

| CRITERIA |
|---|
| ENVIRONMENTAL |
| Climate Change |
| Biodiversity |
| Resource use |
| Environmental Management & Geophysical risk |
| SOCIAL |
| Occupant wellbeing |
| Accessibility |
| Security |
| Social and cultural value |
| ECONOMIC |
| Financing and management |
| Whole life value |
| Externalities |

# 7. The GPP - Green Public Procurement environmental criteria

In the present paragraph the environmental criteria proposed by the European GPP Training tool kit are presented in order to consider the issues mainly elaborated at European level for the building's environmental performance evaluation.

It is important to connect the GPP and the European Ecolabel for buildings, both promoted by the EU in the framework of the Integrated Product Policy, in order to make the most of possible synergies. Therefore terms, indicators and criteria proposed for the GPP on construction products have been considered and possibly adopted in order to be consistent within the European framework.

## 7.1 INTRODUCTION

The potential of GPP as a policy instrument has been increasingly recognised, and over recent years there has been growing political commitment at national, EU and international levels. In 2002, the OECD adopted a Recommendation on green public procurement. As a follow-up to the Johannesburg World Summit on Sustainable Development (September 2002), a Marrakech Task force on sustainable procurement was created with the aim of spreading sustainable (green) public procurement practices. Sustainable procurement policies have been launched in many OECD countries (USA, Japan, Canada, Australia, and South Korea) as well as in rapidly developing countries (such as China, Thailand, and Philippines).

Within the EU, the potential of GPP was first highlighted in the 2003 Commission Communication on Integrated Product Policy where Member States were recommended to adopt national action plans for GPP by the end of 2006. The new European legal framework for public procurement has clarified how public purchasers can include environmental considerations in their procurement processes and procedures. Most recently, the renewed EU Sustainable Development Strategy (June 2006), set the policy objective for 2010 of bringing the average level of EU green public procurement up to the standard achieved by the best performing Member States in 2006.

On 16 July 2008 the Commission presented a proposal to set ambitious targets for green public procurement linked to common green procurement criteria.

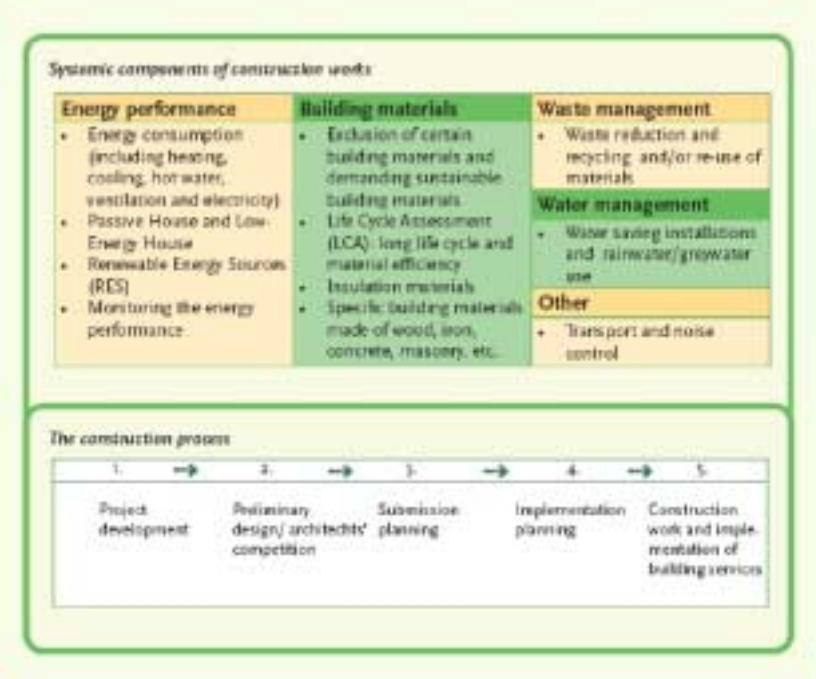
The Communication is part of the Action Plan on Sustainable Consumption and Production and Sustainable Industrial Policy (SCP/SIP), which establishes a framework for the integrated implementation of a mix of instruments aimed at improving the energy and environmental performances of products.

## 7.2 CRITERIA

In the European Green Public Procurement Training Toolkit, two sets of criteria are presented:

Core GPP criteria address the most significant environmental impacts, and are designed to be used with minimum additional verification effort or cost increases.

- **Comprehensive GPP criteria** are intended for use by authorities who seek to purchase the best environmental products available on the market, and may require additional administrative effort or imply a certain cost increase as compared to other products fulfilling the same function.






## 2 Key environmental impacts

| Impact | GPP Approach |
|---|---|
| The consumption of energy for heating, cooling, ventilation, hot water, and electricity, and resulting $CO_2$ emissions | • Maximise the energy performance of buildings<br>• Ensure high energy efficiency standards for heating, cooling, ventilation and hot water systems, and electronic devices<br>• Encourage the use of localised renewable energy sources (l-RES)[1]<br>• Include a systematic Life Cycle Approach (LCA) for building materials<br>• Encourage the use of sustainably harvested and produced resources<br>• Encourage the installation of high-end water saving technologies and reduce the use of freshwater during the construction process.<br>• Encourage the use of non-toxic building materials<br>• Encourage the use of substitute substances/materials for dangerous building materials[3]<br>• Use energy efficient vehicles for transportation and on the building site<br>• Apply effective supply chain management systems |
| The consumption of natural resources | |
| The consumption of fresh water resources both during construction and during the use phase | |
| Emission of substances harmful to human health and the environment during the production or disposal of building materials leading to air and water pollution | |
| Negative health impacts on building users due to building materials containing dangerous substances[2] | |
| $CO_2$ emissions resulting from the transportation of construction materials and products | |

[1] *"Localised RES" means RES generating capacity within the building site itself (e.g. solar panels, biomass boilers, wind turbines etc.).*
[2] *Defined and listed in Directive 76/796/EEC.*
[3] *Contracting authorities must ensure that the functionality of the buildings materials is not compromised (for example in terms of resistance to fungal growth) when using substitute substances/ materials.*

## *7.3 CONSTRUCTION*

### 7.3.1 Core GPP criteria

**Subject matter**

- Construction of new energy efficient, using environmental friendly construction materials and products **or**
- Renovation of building stock of to high energy efficiency standards using environmental friendly construction materials and products.

**Selection criteria**

1-Exclusion of certain contractors
Construction companies, which have repeatedly acted against environmental legislation or regulations or have been found guilty of grave professional misconduct as outlined in Articles 53 and 5 of Directive 00 /17/EC and Article 5 of Directive 00 /18/EC, will be excluded from the tendering procedure.

2-Experience of the architect in environmental construction
The architect must demonstrate sufficient experience with environmental building design. This may include reference to associated specialists e.g. engineering consultants for heating/cooling systems. Each applicant is required to submit a -page document outlining (past) experience in the following areas (indicative list):

Energy efficient construction design. Including, if available, specific energy demand per $m^2$ including heating, cooling, lighting and ventilation for a previous construction.

Design of air-tight and air exchange systems with heat recovery.

Bioclimatic architecture, to achieve energy efficiency, thermal and optical comfort, and good indoor air quality standards, avoiding mechanical systems, e.g. light supply with daylight systems.

Use of environmental construction materials and products.

3-Technical capacity to take the necessary environmental management measures in order to ensure that the construction works are executed in an environmental friendly way.
Bidders must demonstrate their technical capacity (either by having the expertise within the company or by co-operation with experts) to put in place certain environmental management measures that meet the following requirements:

- Ensuring effective protection of fauna and flora in the building area and its surroundings (where construction takes place in an environmentally sensitive area).
- Measures to prevent any harmful waste and hazardous substance flows that may adversely impact the area.
- Environmental management measures aimed at minimising waste production on the site, respecting noise regulations and avoiding traffic congestion.

Verification:

Possible means of proof include EMAS and ISO 1 001 certificates or equivalent certificates issued by bodies conforming to Community law or the relevant European or international standards concerning certification based on environmental management standards. Other means of evidence provided by the company that can prove the required technical capacity will also be accepted.

**Specifications and award criteria**

***Energy performance***

*Specification*

Energy consumption standards
1- The overall [net/final/primary]energy demand of the building (including heating, cooling, hot water, ventilation and electricity) is [X]% lower than the maximum defined in [insert relevant national legislation].

Display panel
2- A display panel must be installed prominently in the building indicating daily and/or monthly energy consumption for the whole building. Further explanations about the outdoor climate conditions and the current use, reflecting the user schemes of the type of building (school, office etc) should be included too, in order to contribute to interpretations of the given data.

Energy efficiency training
3-A training session must be given to the building manager on the energy efficient use of the building following the completion of construction/renovation works. The bidder must outline the content of the training.

*Award criteria*

Additional points will be awarded for:

Lowest energy consumption
Lower energy consumption than that demanded in the specifications, based on the overall [net/final/primary] energy demand of the building (including heating, cooling, hot water, ventilation and electricity). Points will be awarded on the basis of a sliding scale between the best and worst bids.

**Implementation notes**

*General note:* It is recommended to evaluate which would be the best phase for including each of the proposed environmental criteria (architect's design competition, tendering procedure for construction works).

*Energy consumption standards:* The choice of net, final or primary energy demand will depend on the indicators used for defining energy performance included in national legislation. The contracting authority should clearly state the applicable legislation (see Annex 1, Table 13 in the Construction Background report).

When evaluating the incoming bids contracting authorities must verify whether the relevant calculation method has been correctly implemented. This might need external/internal expert input.

*Energy consumption standards – defining percentage levels:* The percentage level (ambition level) to insert highly depends on the ambition level of the maximum energy performance defined in national legislation. It is recommended to aim for at least 0% lower than the existing national standard demands.

*Energy consumption standards – recommended stage of the construction process:* Energy demand thresholds should be included in all stages of the procurement process.

*Display panels:* Depending on the building size and the level of implementation of the Environmental Performance of Buildings Directive in the respective Member States the installation of an energy display may already be mandatory. For further information see www.buildingsplatform.org.

*Award criteria:* Contracting authorities will have to indicate in the contract notice and tender documents how many additional points will be awarded for each award criterion. Environmental award criteria should, altogether, account for at least 10 to 15 % of the total points available. Where the award criterion is formulated in terms of "better performance as compared to the minimum requirements included in the technical specifications", points will be awarded in proportion to the improved performance.

***Building materials/construction products***

*Specifications*

Exclusion of certain materials

- Bidders must declare that the following materials/substances will not be used in the building:
- Recycled wood-based products (e.g. timber), plastics, steel or other materials not accompanied by test documents indicating that they contain no hazardous substances (as defined by national regulations).
- Products which contain hydrofluorocarbons (HFCs).
- Products which contain sulphurhexafluoride (SF ).
- Indoor paints and varnishes with a content of solvents (volatile organic compounds (VOCs) with a boiling point of 50°C maximum) higher than:
  - for wall paints (according to EN 13300): 30 g/l (minus water).

  - for other paints with a spreading rate of at least 15 $m^2$/l at a hiding power of 98% opacity: 50 g/l (minus water).

  - for all other products (including paints that are not wall paints and that have a spreading rate of less than 15m /l, varnishes, wood stains, floor coatings and floor.

  paints, and related products): 180g/l (minus water).

*Verification:*

Bidders must declare that these products/substances will not be used in the building.

Timber

Timber used in the building shall come from legal sources.

*Verification:*

Certificates of chain of custody for the wood fibres certified as FSC, PEFC or any other equivalent means of proof, will be accepted as proof of compliance. The legal origin of the wood can also be demonstrated with a tracing system being in place. These voluntary systems may be 3rd party certified, often as part of ISO 9000 and/or ISO 1 000 or EMAS management systems.

If wood stems from a country that has signed a Voluntary Partnership Agreement (VPA) with the EU, the FLEGT license will serve as proof of legality.

For the non-certified wood bidders shall indicate the types (species), quantities and origins, together with a declaration of legality. As such the wood shall be able to be traced throughout the whole production chain from the forest to the product. In specific cases, where the evidence provided is not considered sufficient to prove compliance with the requested technical specifications, contracting authorities may ask suppliers for further clarifications of proof.

Volatile Organic Compounds (VOC)

The VOC emissions from the building products used must not exceed the respective values outlined in the European standard for the determination of emissions from building products EN ISO 1 000-9 to -11 or equivalent.

*Verification:*

Test report based on the outlined method in EN ISO 1 000-9 to –11.

*Award criteria*

Use of environmental construction materials and products
Bidders must indicate the percentage of [insert relevant product types, e.g. windows, paints, insulation materials] to be used in construction (by value) that are produced in compliance with the standards underlying a Type I Ecolabel according to ISO standard 1 0 . Additional points will be awarded in proportion to the percentages proposed.

*Verification:*

Products carrying a type I Ecolabel will be deemed in compliance with these criteria. Alternatively credible documentation that the standards of a given type I Ecolabel are met will also be accepted.

Sustainable forestry sources
Wood products coming from forests that are managed so as to implement the principles and measures aimed at ensuring sustainable forest management, on condition that these criteria characterize and are relevant for the product.

In Europe, these principles and measures shall at least correspond to those of the Pan-European Operational Level Guidelines for Sustainable Forest Management, as endorsed by the Lisbon Ministerial Conference on the Protection of Forests in Europe (to June 1998). Outside Europe they shall at least correspond to the UNCED Forest Principles (Rio de Janeiro, June 199 ) and, where applicable, to the criteria or guidelines for sustainable forest management as adopted under the respective international and regional initiatives (ITTO, Montreal Process, Tarapoto Process, UNEP/FAO Dry-Zone Africa Initiative).

*Verification:*

Certificates of chain of custody for the wood fibres certified as FSC11, PEFC1 or any other equivalent means of proof, will be accepted as proof of compliance.

Any other appropriate means of proof, such as a technical dossier of the manufacturer or a test report from a recognised body will also be accepted.

**Implementation notes**

*General note:* It is recommended to evaluate which would be the best phase for including each of the proposed environmental criteria (architect's design competition, tendering procedure for construction works).

*Exclusion of materials – monitoring:* The contracting authority must set up a proper monitoring and evaluation system during the construction process that, besides general quality control issues, also focuses on the monitoring and control of the excluded substances.

Where the criterion is included in the award phase appropriate financial penalties will need to be put in place to ensure that the target stated in the original offer from the bidder is met when carrying out the contract.

*Award criteria:* Contracting authorities will have to indicate in the contract notice and tender documents how many additional points will be awarded for each award criterion. Environmental award criteria should, altogether, account for at least 10 to 15 % of the total points available.

*Use of environmental construction materials and products – specifications or award:* It is proposed to use these criteria in the award phase as the contracting authority will likely not have sufficient knowledge of the market availability and price of such products. If the contracting authority has good market knowledge, it could include minimum percentages for certain product types in the

specifications. Different information hubs exist in Europe, giving detailed information on sustainable building materials such as established information websites of respective ecolabels. Please see the ecolabel section in the Construction Background Report.

***Water saving installations***

*Specifications criteria*

Water saving installations
All sanitary and kitchen water facilities must be equipped with the latest water-saving technologies available on the market.

Dual flush WCs should use a maximum of litres for full flush and 3 litres for urine flush.

Waterless urinals have to either use a biodegradable fluid or operate completely without fluid.

Water saving devices fitted into cisterns must demonstrate water saving of at least 30% for toilet flushing. Tap inserts should save at least 50% of water compared to normal tap use.

Verification:
Bidders must provide technical data-sheets for the products to be installed that verify compliance with the specifications.

**Implementation notes**

*General note:* It is recommended to evaluate which would be the best phase for including each of the proposed environmental criteria (architect's design competition, tendering procedure for construction works).

*Water saving installations – verification:* In order to set the specifications and verify compliance, the contracting authority should have an overview of available technologies such as tap attachments and water flow restrictors on the market. The criteria can be adapted as necessary to fit market availability. Those presented in the criteria above are adapted from the UK National Water Supply Regulations based on the implementation of European Directive 000/ 0/EC establishing a framework for Community action in the field of water policy.

Contract performance clauses

Compulsory blower door test
Where mechanical ventilation is included in the building, the contractor must ensure that a 'Blower Door Test' is carried out at [insert appropriate building stage]. This must be repeated until the appropriate standard is achieved.

Book-keeping
The contractor must provide a regular book-keeping service for the first three years that will provide the building manager with monthly figures on energy consumption for heating, cooling, ventilation, hot water, and electricity.

Transport and recycling of building materials
The use of reusable containers to transport the necessary building materials to, on and from the construction site is obligatory.

Suppliers of building materials must take back, recycle and reuse packaging that comes with the building materials.

Preference should be given to transporting the goods with vehicles meeting at least the EURO III standard, or vehicles using alternative fuels (e.g. bio fuels) as well as transport by train and/or ship.

Waste reduction and management

The contractor must put appropriate measures in place to reduce and recycle waste that is produced during the construction process. It is required to have a recycling rate of

at least 0% related to weight percentage segregation.

*Verification:*

Proof of compliance can be provided by an Environmental Management System (EMS) such as EMAS (or equivalent).

**Implementation notes**

*Blower door test – appropriate building stage:* The appropriate time for a blower door test to be carried out will depend on the type of building (e.g. for a wooden construction after the assembly of windows, doors and steam brakes).

*Transport and recycling of building materials:* It may also be a good option to require that goods be shipped to a dedicated rail or inland waterway facility. This is only applicable, if more than one potential contractor is actually able to use rail or inland waterway networks.

### 7.3.2 Comprehensive GPP criteria

**Subject matter**

Construction of new/renovation of [insert building type], achieving an energy performance similar to the passive house standard, using sustainable construction materials, considering intelligent energy service solutions, sustainable water and waste water management aspects and ambitious healthy living conditions.

**Selection criteria**

Exclusion of certain contractors

Construction companies which have repeatedly acted against environmental legislation or regulations or have been found guilty of grave professional misconduct as outlined in Articles 53 and 5 of Directive 00 /17/EC and Article 5 of Directive 00 /18/EC will be excluded from the tendering procedure.

Experience of the architect in environmental construction

The architect must have sufficient past and associated experience with environmental building design. This can include reference to associated specialists e.g. engineering consultants for heating/cooling systems. Each applicant is required to submit a -page document outlining experience in the following areas (indicative list):

- Energy efficient construction design. Including, if available, specific energy demand per $m^2$ including heating, cooling, ventilation and lighting for a previous construction.
- Air-tightness and air exchange systems with heat recovery.
- The use of renewable energy sources and co-generation.
- Bio-climatic architecture, to achieve energy efficiency, thermal and optical comfort, avoiding mechanical systems, e.g. light supply with daylight systems.
- Use of LCC and LCA tools in design.
- Use of environmental construction materials and products.

- Achievement of good indoor air quality standards.

Technical capacity to take the necessary environmental management measures in order to ensure that the construction works are executed in an environmental friendly way

-Bidders must demonstrate their technical capacity (either by having the expertise within the company or by co-operation with experts) to put in place certain environmental management measures that meet the following requirements:

- Ensuring effective protection of fauna and flora in the building area and its surroundings (where construction takes place in an environmentally sensitive area).

- Measures to prevent any harmful waste and hazardous substance flows that may adversely impact the area.

- Environmental management measures aimed at minimising waste production on the site, respecting noise regulations and avoiding traffic congestion.

*Verification:*

Possible means of proof include EMAS and ISO 1 001 certificates or equivalent certificates issued by bodies conforming to Community law or the relevant European or international standards concerning certification based on environmental management standards. Other means of evidence provided by the company that can prove the required technical capacity will also be accepted.

**Implementation notes**

*Experience of the architect in environmental construction:* Judging the experience of the architect requires experience from the contracting authority. It may be appropriate to bring in external expertise and set up a jury that combines common knowledge to judge the experience statements of competing architects. This list is indicative and can be expanded/reduced to fit the situation. It will be necessary for the authority to determine what appropriate past experience means.

*Exclusion for grave professional misconduct:* Contracting companies can only be excluded if the national laws of a Member State include provisions on environmental law, and where the violation of such laws (and a final decision in this sense by a court) would constitute grave professional misconduct; bidders who have been convicted in this sense could be excluded (Articles 53 and 5 of Directive 00 /17/EC and Article 5 of Directive 00 /18/EC).

***Energy performance - Option 1***

*Specifications*

Energy performance standard

The energy performance must meet the criteria underlying the following Passive House standard

**Implementation notes**

Passive House requirements: Passive houses aim to achieve a very high energy performance in buildings by using as much passively generated heating, cooling and ventilation as possible and thereby reducing energy consumption significantly compared to average buildings. (Please also see further information in the Background Report.)

The contracting authority will need to define the most appropriate criteria to apply. The following Passive House specifications can be used as a baseline:

- Passiv Haus Institute Standard (Germany): www.passiv.de.

- MINERGIE-P (Switzerland): www.minergie.ch/index.php?standards- .

- PassivHausUK (UK): www.passivhaus.org.uk.

- CEPHEUS Project (EU): www.cepheus.de/eng.

- European Passive Houses (EU): www.europeanpassivehouses.org.

***Energy performance - Option 2***

*Specifications*

Localised RES (l-RES)
A minimum of [X]% of [net, final or primary] energy demand must be provided by localised renewable energy sources (l-RES). L-RES means renewable energy source generating capacity within the building site itself (e.g. solar panels, biomass boilers, wind turbines etc.).

Energy consumption standards
The overall [net/final/primary] energy demand of the building (including heating, cooling, hot water, ventilation and electricity) is [X]% lower than the maximum defined in [insert relevant national legislation].

*Award criteria*

Innovative energy efficient building services
Bidders must submit specific proposals for achieving energy efficient lighting, heating, cooling and ventilation in the building. Additional points will be awarded for the proposed approach, by evaluating the estimated energy savings (in comparison to standard systems) and the use of passive components (e.g. insulation, daylight use).

Lower energy consumption
Lower energy consumption than that demanded in the specifications, based on the overall [net/final/primary] energy demand of the building (including heating, cooling, hot water, ventilation and electricity). Points will be awarded on the basis of a sliding scale between the best and worst bids.

**Implementation notes**

*General note:* It is recommended to evaluate which would be the best phase for including each of the proposed environmental criteria (architect's design competition, tendering procedure for construction works).

*Localised RES (l-RES) percentage*: The contracting authority will need to determine the appropriate minimum % of l-RES. This will largely depend on the climatic conditions and the experience with l-RES installation. Typically this should be between 5- 0%.

*Energy consumption standards:* The choice of net, final or primary energy demand will depend on the indicators used for defining energy performance provided in national legislation. The contracting authority should clearly state the applicable legislation (see Annex 1, Table 13 in the Construction Background Report).

When evaluating the incoming bids contracting authorities must verify the correct use of the applicable calculation method. This might need external/internal expert input.

*Energy consumption standards – defining percentage levels:* The percentage level (ambition level) to insert highly depends on the ambition level of the maximum energy performance defined in national legislation. It is recommended to aim for at least 0% lower than the existing national standard demands.

*Building services:* Construction works also includes the installation of heating, ventilation, air conditioning and refrigeration (HVACR) as well as energy supply, lighting and water systems. A specialist company may be contracted to design and install (and sometimes maintain) these services for the building – often called "building services".

*Award criteria:* Contracting authorities will have to indicate in the contract notice and tender documents how many additional points will be awarded for each award criterion. Environmental award criteria should, altogether, account for at least 10 to 15 % of the total points available. Where the award criterion is formulated in terms of "better performance as compared to the minimum requirements included in the technical specifications", points will be awarded in proportion to the improved performance.

*Energy consumption standards – recommended stage of the construction process:* Energy demand thresholds should be included in all stages of the procurement process.

### *Energy performance - General*

*Specifications*

Display panel
A display panel must be installed prominently in the building indicating daily and/or monthly energy consumption for the whole building. Further explanations about the outdoor climate conditions and the current use, reflecting the user schemes of the type of building (school, office etc) should be included too, in order to contribute to interpretations of the given data.

Energy efficiency training
A training session must be given to the building manager on the energy efficient use of the building following the completion of construction/renovation works. Bidders must outline the content of the training.

**Implementation notes**

*General note:* It is recommended to evaluate which would be the best phase for including each of the proposed environmental criteria (architect's design competition, tendering procedure for construction works).

*Display panels:* Depending on the building size and the level of implementation of the Environmental Performance of Buildings Directive in the respective Member States the installation of an energy display may already be mandatory.

### *Building materials/construction products*

*Specifications*

Recycled/re-used content
[X%] of [insert relevant construction materials, e.g. wood, concrete, glass] must derive from recycled or re-used content.

*Verification:*

Any type I Ecolabel which indicates the % of recycled content as well as EPDs and self-declarations from the manufacturer will serve as proof of compliance.

Exclusion of certain materials
Bidders must declare that the following materials/substances will not be used in the building:

Recycled wood-based products (e.g. timber), plastics, steel or other materials not accompanied by test documents indicating that they contain no hazardous substances (as defined by national regulations).

Products which contain hydrofluorocarbons (HFCs).

Products which contain sulphurhexafluoride (SF ).

Indoor paints and varnishes15 with a content of solvents (volatile organic compounds (VOCs) with a boiling point of 50°C maximum) higher than:

- for wall paints (according to EN 13300): 30 g/l (minus water).

- for other paints with a spreading rate of at least 15 $m^2$/l at a hiding power of 98% opacity: 50 g/l (minus water).

- for all other products (including paints that are not wall paints and that have a spreading rate of less than 15m /l, varnishes, wood stains, floor coatings and floor paints, and related products): 180g/l (minus water).

*Verification:*

Bidders must declare that these products/substances will not be used in the building.

Timber

3. Timber used in the building shall come from legal sources.

*Verification:*

Certificates of chain of custody for the wood fibres certified as FSC, PEFC or any other equivalent means of proof, will be accepted as proof of compliance. The legal origin of the wood can also be demonstrated with a tracing system being in place. These voluntary systems may be 3rd party certified, often as part of ISO 9000 and/or ISO 1 000 or EMAS management systems.

If wood stems from a country that has signed a Voluntary Partnership Agreement (VPA) with the EU, the FLEGT license may serve as proof of legality.

For the non-certified wood bidders shall indicate the types (species), quantities and origins, together with a declaration of legality. As such the wood shall be able to be traced throughout the whole production chain from the forest to the product. In specific cases, where the evidence provided is not considered sufficient to prove compliance with the requested technical specifications, contracting authorities may ask suppliers for further clarifications or proof.

Volatile Organic Compounds (VOC)

The VOC emissions from the building products used must not exceed the respective values outlined in the European standard for the determination of emissions from building products EN ISO 1 000-9 to -11 (see: www.iso.org), or equivalent.

*Verification:*

Test report based on the outlined method in EN ISO 1 000-9 to –11 or equivalent.

Steel

[Applicable for renovation work] For the purpose of cleaning, derusting and removing paint from steel products, silicon-blasting agents must not be used. Residual materials must be disposed of according to relevant national legislation.

*Verification:*

Bidders must declare that this criterion will be met.

Brick, concrete, others..

*Award criteria*

Additional points will be awarded for:

[For countries where sufficient LCA data for building materials exists] LCA comparison of construction materials

For the building materials envisaged in the design phase for the main construction (e.g. shell, walls, roof, etc.) LCA data must be presented by bidders. To ensure the comparability of offers the LCA tool [insert name of LCA tool] must be used. Points will be awarded on the basis of a sliding scale between the best and worst bids.

Competition around R-values (combination of lambda and the thickness of insulation products) of the proposed insulation

Bidders must provide the R-values of the proposed insulation materials. Points will be awarded on a sliding scale between the best and worst bids.

*Verification:*

Test documentation of the proposed insulation material/solution using an accredited R-value calculation standard for insulation must be provided.

Use of environmental construction materials and products

Bidders must indicate the percentage of [insert relevant product types, e.g. windows, paints, insulation materials] to be used in construction (by value) that are produced in compliance with the standards underlying a Type I Ecolabel according to ISO standard 1 0 . Additional points will be awarded in proportion to the percentages proposed.

*Verification:*

Products carrying a type I Ecolabel will be deemed in compliance with these criteria. Alternatively credible documentation that the standards of a given type 1 Ecolabel are met will also be accepted.

Sustainable forestry sources

Wood Products coming from forests that are managed so as to implement the principles and measures aimed at ensuring sustainable forest management, on condition that these criteria characterize and are relevant for the product.

In Europe, these principles and measures shall at least correspond to those of the Pan-European Operational Level Guidelines for Sustainable Forest Management, as endorsed by the Lisbon Ministerial Conference on the Protection of Forests in Europe ( to June 1998). Outside Europe they shall at least correspond to the UNCED Forest Principles (Rio de Janeiro, June 199 ) and, where applicable, to the criteria or guidelines for sustainable forest management as adopted under the respective international and regional initiatives (ITTO, Montreal Process, Tarapoto Process, UNEP/FAO Dry-Zone Africa Initiative).

*Verification:*

Certificates of chain of custody for the wood fibres certified as FSC , PEFC 3 or any other equivalent means of proof, will be accepted as proof of compliance. Any other appropriate means of proof, such as a technical dossier of the manufacturer or a test report from a recognised body will also be accepted.

**Implementation notes**

*General note:* it is recommended to evaluate which would be the best phase for including each of the proposed environmental criteria (architect's design competition, tendering procedure for construction works).

*Recycled/re-used content:* a minimum requirement should be 5%. If award criterion 1 (LCA comparison of building materials) is used, a relatively low percentage should be set.

*Recycled/re-used content – specification or award criteria:* where the contracting authority is unable to define the availability of recycled/re-used content, this criterion could instead be used in the award phase.

*Use of environmental construction materials and products – specifications or award:* it is proposed to use this criterion in the award phase as the contracting authority will likely not have sufficient knowledge of the market availability and price of such products. If the contracting authority has good market knowledge, minimum percentages for certain product types could be included in the specifications. Different information hubs exist in Europe, giving detailed information on sustainable building materials such as established information websites of respective ecolabels. Please see the ecolabel section in the Construction Background Report.

*Award criteria:* contracting authorities will have to indicate in the contract notice and tender documents how many additional points will be awarded for each award criterion. Environmental award criteria should, altogether, account for at least 10 to 15 % of the total points available. Where the award criterion is formulated in terms of "better performance as compared to the minimum requirements included in the technical specifications", points will be awarded in proportion to the improved performance.

*LCA comparison of construction materials:* the availability of LCA data on building materials varies considerably from country to country. The contracting authority will need to consider whether sufficient data exists to apply this award criterion. The contracting authority will also need to determine which LCA tools are most appropriate for the region/type of construction work. A list of suitable LCA tools is available in section in the Construction Background Report.

***Noise reduction***

*Award criteria*

Additional points will be awarded for:

Construction site noise reduction
The construction machinery used must comply with the basic criteria of the Blue Angel Ecolabel for Low-Noise Construction Machinery (RAL-UZ 53), available at http://www.blauer-engel.de/englisch/vergabe/download_uz_e/e-UZ-053_ 007.zip .

*Verification:*

All products carrying the Blue Angel ecolabel will be deemed to comply. Any other appropriate means of proof, such as a technical dossier of the manufacturer or a test report from a recognised body will also be accepted.

Internal noise reduction
Bidders must provide a proposal on how to reduce acoustic bridges in the interior to improve healthy living conditions. Points will be awarded on a sliding scale between the best and worst bids.

**Implementation notes**

*General note:* It is recommended to evaluate which would be the best phase for including each of the proposed environmental criteria (architect's design competition, tendering procedure for construction works).

*Award criteria:* Contracting authorities will have to indicate in the contract notice and tender documents how many additional points will be awarded for each award criterion. Environmental award criteria should, altogether, account for at least 10 to 15 % of the total points available.

***Water saving***

*Specifications*

Water-saving installations
All sanitary and kitchen water facilities must be equipped with the latest water-saving technologies available on the market.

- Dual flush WCs should use a maximum of litres for full flush and 3 litres for urine flush.
- Waterless urinals have to either use a biodegradable fluid or operate completely without fluid.
- Water saving devices fitted into cisterns must demonstrate water saving of at least 30% for toilet flushing.
- Tap inserts should save at least 50% of water compared to normal tap use.

*Verification:*

Bidders must provide technical data-sheets for the products to be installed that verify compliance with the specifications.

At least [X]% of the number of urinals and toilets must use waterless technologies.

*Verification:*

Bidders must indicate the number and percentage of waterless installations foreseen.

*Award criteria*

Additional points will be awarded for:

Rainwater and grey-water use
Bidders must provide a proposal on how to maximise the use of rainwater and grey-water in the water supply and return system of the building. Additional points will be awarded based on the proposals submitted.

The proposals will be rated according to the following criteria:

- Design and quality of the technology including adaptability to the building design.
- Estimated percentage of overall water supply from rainwater and grey-water sources.
- Maintenance costs and durability of the product (installation and maintenance costs).

**Implementation notes**

*Water saving installations – verification:* In order to set the specifications and verify compliance, the contracting authority should have an overview of available technologies such as tap attachments and water flow restrictors on the market. The criteria can be adapted as necessary to fit market availability. Those presented in the criteria above are adapted from the UK National Water Supply Regulations based on the implementation of European Directive 000/ 0/EC establishing a framework for Community action in the field of water policy. See also the Sustainable Products Catalogue at http://www.globaltolocal.com/G L_ESPO% 0Catalogue.php.

*Water saving installations – defining percentages:* The level of ambition (X%) strongly depends on the market availability of the demanded technologies (e.g. NoMix-toilet systems) in the specific European region. Where the contracting authority is unfamiliar with the market situation, it is recommended to use this criterion in the award phase in order to set a realistic demand.

*Rainwater and grey-water use – specifications or award phase:* It is also possible to set minimum percentages of overall water supply from rainwater and grey-water sources; however the potential will vary considerably according to climatic conditions. Therefore local expertise would be needed to set appropriate levels.

*Award criteria:* Contracting authorities will have to indicate in the contract notice and tender documents how many additional points will be awarded for each award criterion. Environmental award criteria should, altogether, account for at least 10 to 15 % of the total points available.

# 8. Main issues to be considered

This chapter provides elements collected in the analysis carried out in order to elaborate a proposal for discussion on the main issues to be considered in the European Ecolabel criteria development.

The table below is the result of a synthesis of the following elements:

- Principal environmental aspects pointed out from the LCA methodology;
- principal issues used in different certification schemes examined;
- Indicators/focal points identified within the existing initiatives at European level (CEN/TC 350, CPR proposal, GPP criteria for construction).

The main issues to be considered are organised according to the life cycle phases of the building.

**Table 8.1: Issues for the development of EU Ecolabel criteria for buildings**

| | Project | Construc. | Use and mainten. | Refurbish. | End of Life |
|---|---|---|---|---|---|
| **Environmental issues** | | | | | |
| **Environmental loadings** | | | | | |
| Emission in atmosphere | | x | x | x | x |
| Emission to the soil | | x | x | x | x |
| Emission to the water | | x | x | x | x |
| Wastes | | x | x | x | x |
| … | | | | | |
| **Resource use** | | | | | |
| Energy | | x | x | x | x |
| Materials | x | x | x | x | x |
| Water | x | x | x | x | x |
| Land use | x | x | | x | x |
| Site selection | x | | | x | x |
| … | | | | | |
| **Health and safety** | | | | | |
| Indoor quality | | | x | x | |
| Noise | | | x | x | |
| Comfort | x | x | x | x | |
| Daylighting and illumination | x | x | x | x | |
| …. | | | | | |

| | Project | Construc. | Use and mainten. | Refurbish. | End of Life |
|---|---|---|---|---|---|
| **Social issues** | | | | | |
| Relation with the territory | ? | | | | |
| Outdoor environmental quality | | | | | |
| Social and cultural value | | | | | |
| …. | | | | | |
| **Economic issues / Fitness for use** | | | | | |
| **Service quality** | | | | | |
| Management | x | | x | | |
| Maintenance | x | | x | | |
| Performance | | | x | | |
| Functionality | x | | x | | |
| ….. | | | | | |
| **Services** | | | | | |
| Transport | | | x | | |
| Waste collection | x | | x | x | |
| Common services (e.g. wash-machines..) | x | | x | x | |
| Parking (auto, bike) | x | | x | x | |
| ….. | | | | | |
| **Costs** | | | | | |
| Management/Maintenance costs | ? | | | | |
| External costs | | | | | |
| …. | | | | | |

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# 10. Annex 1 – LCI data from § 5.2

**Table 10.1: Input flow data of the LCA of case IT/A**

| TYPE OF FLOW | INPUT FLOW | RESULTING AMOUNT | U.M. |
|---|---|---|---|
| Product flow | All materials of building and plants for construction and end of life phases | | |
| Product flow | Thermic energy for winter conditioning of 4 apartments with natural gas boiler | 8654100 | MJ |
| Product flow | Electric energy for domestic use and for the building | 700000 | kWh |

**Table 10.2: Output flow data of the LCA of case IT/A**

| TYPE OF FLOW | OUTPUT TYPE | OUTPUT FLOW | Total RESULTING AMOUNT | U.M. |
|---|---|---|---|---|
| Elementary flow | Raw material | Clay (some types) | 1,104E+05 | kg |
| Elementary flow | Raw material | Coal (some types) | 6,676E+04 | kg |
| Elementary flow | Raw material | Copper (in ore) | 3,479E+02 | kg |
| Elementary flow | Raw material | Natural gas (some types) | 2,432E+05 | kg |
| Elementary flow | Raw material | Gypsum | 7,300E+03 | kg |
| Elementary flow | Raw material | Gravel | -8,590E+02 | kg |
| Elementary flow | Raw material | Iron (some types) | 2,093E+04 | kg |
| Elementary flow | Raw material | Crude Oil (some types) | 1,024E+05 | kg |
| Elementary flow | Raw material | Sand (some types) | 3,970E+05 | kg |
| Elementary flow | Raw material | Water (some types) | 4,324E+05 | kg |
| Elementary flow | Raw material | Wood (some types) | 1,027E+04 | kg |
| Elementary flow | Emission to air | Carbon dioxide (some types) | 1,127E+06 | kg |
| Elementary flow | Emission to air | Ethene | 1,270E+03 | kg |
| Elementary flow | Emission to air | Nitrogen oxides | 2,040E+03 | kg |
| Elementary flow | Emission to air | Sulphur oxides | 4,204E+03 | kg |
| Elementary flow | Emission to air | Ra226 to water | 1,690E+04 | Bq |
| Elementary flow | Emission to air | Methane | 2,320E+03 | kg |
| Elementary flow | Emission to air | NMVOC | 8,630E+02 | kg |
| Elementary flow | Emission to air | Particulates (some types) | 1,115E+04 | kg |
| Elementary flow | Emission to water | Cl- | 3,270E+03 | kg |
| Elementary flow | Emission to water | Nitrate | 5,210E+00 | kg |
| Elementary flow | Emission to water | Phosphate | 4,720E+00 | kg |
| Elementary flow | Emission to water | Sulphate | 6,820E+02 | kg |
| Elementary flow | Emission to soil | Iron | 8,110E-01 | kg |

**Table 10.3: Input flow data of the LCA of case IT/B**

| LC phase | TYPE OF FLOW | INPUT FLOW | RESULTING AMOUNT | U.M. |
|---|---|---|---|---|
| **BASE CASE** | | | | |
| Construction | Product flow | All materials of building and plants | | |
| Construction | Product flow | Winter energy consumption with gas boilers | 1553800 | MJ |
| Use and maintenance | Product flow | En.el. LV mix Italia (use) | 220000 | kWh |
| Use and maintenance | Product flow | Tap water (use) | 23652 | t |
| Use and maintenance | Product flow | Energy consumption for hot sanitary water | 0,45 | TJ |
| **LOW ENERGY CASE** | | | | |
| Construction | Product flow | All materials of modified building and plants | | |
| Construction | Product flow | Winter energy consumption with heat pump (COP=3) | 79740.7 kWh | kWh |
| Use and maintenance | Product flow | Winter energy consumption with heat pump (COP=3) | 13906,242 | kWh |
| Use and maintenance | Product flow | Tap water (use) | 23652 | t |
| Use and maintenance | Product flow | Energy consumption for hot sanitary water from solar collector (5 panels, 25m2 in 100 years) | 0,45 | TJ |
| Use and maintenance | Product flow | Electric energy from photovoltaic plant (3,333 panels of 51,33 mq) | 220000 | kWh |

**Table 10.4: Output flow data of the LCA of case IT/B**

| TYPE OF FLOW | OUTPUT TYPE | OUTPUT FLOW | TOTAL RESULTING AMOUNT | U.M. |
|---|---|---|---|---|
| **BASE CASE** | | | | |
| Elementary flow | Raw material | Clay(some types) | 2,774E+04 | kg |
| Elementary flow | Raw material | Coal (some types) | 3,482E+04 | kg |
| Elementary flow | Raw material | Gas natural (some types) | 6,610E+04 | kg |
| Elementary flow | Raw material | Gravel, in ground | 1,340E+05 | kg |
| Elementary flow | Raw material | Gypsum | 1,510E+03 | kg |
| Elementary flow | Raw material | Oil (some types) | 2,218E+04 | kg |
| Elementary flow | Raw material | Sand (some types) | 4,580E+04 | kg |
| Elementary flow | Raw material | Water (some types) | 1,112E+09 | kg |

| | | | | |
|---|---|---|---|---|
| Elementary flow | Raw material | Wood (some types) | -8,554E+01 | kg |
| Elementary flow | Emission to air | Carbon dioxide (some types) | 3,659E+05 | kg |
| Elementary flow | Emission to air | Carbon monoxide (some types) | 4,051E+02 | kg |
| Elementary flow | Emission to air | Methane (some types) | 7,189E+02 | kg |
| Elementary flow | Emission to air | Nitrogen oxides | 7,923E+02 | kg |
| Elementary flow | Emission to air | NMVOC | 2,080E+02 | kg |
| Elementary flow | Emission to air | Particulates (some types) | 7,870E+02 | kg |
| Elementary flow | Emission to air | Sulphur oxides | 8,875E+02 | kg |
| Elementary flow | Emission to water | Copper, ion | 3,100E-01 | kg |
| Elementary flow | Emission to water | Radium -228 | 8,48E+03 | Bq |
| Elementary flow | Emission to soil | Iron | 1,59E+03 | kg |
| **LOW ENERGY CASE** | | | | |
| Elementary flow | Raw material | Clay (some types) | 2,974E+04 | kg |
| Elementary flow | Raw material | Coal (some types) | 3,607E+04 | kg |
| Elementary flow | Raw material | Gas natural (some types) | 1,518E+04 | kg |
| Elementary flow | Raw material | Gravel, in ground | 1,340E+05 | kg |
| Elementary flow | Raw material | Oil (some types) | 1,544E+04 | kg |
| Elementary flow | Raw material | Sand, unspecified, in ground | 4,550E+04 | kg |
| Elementary flow | Raw material | Water (some types) | 8,395E+08 | kg |
| Elementary flow | Raw material | Wood (some types) | 1,194E+04 | kg |
| Elementary flow | Emission to air | Carbon dioxide (some types) | 1,262E+05 | kg |
| Elementary flow | Emission to air | Carbon monoxide (some types) | 4,193E+02 | kg |
| Elementary flow | Emission to air | Methane (some types) | 1,862E+02 | kg |
| Elementary flow | Emission to air | Nitrogen oxides | 5,163E+02 | kg |
| Elementary flow | Emission to air | NMVOC | 1,290E+02 | kg |
| Elementary flow | Emission to air | Particulates (some types) | 7,762E+02 | kg |
| Elementary flow | Emission to air | Sulphur oxides | 6,390E+02 | kg |
| Elementary flow | Emission to water | Copper, ion | 4,100E-01 | kg |
| Elementary flow | Emission to water | Radium -227 | 1,88E+07 | Bq |
| Elementary flow | Emission to soil | Iron | 1,59E+03 | kg |

# 11. Annex 2 – List of examined criteria

**Table 11.1: The iiSBE criteria**

| | CRITERIA | Type of requirement | |
|---|---|---|---|
| | **A - SITE SELECTION, PROJECT PLANNING AND DEVELOPMENT** | **on/off** | **rating** |
| | **A1 - Site Selection** | | |
| | A1.1 Pre-development ecological value or sensitivity of land | X | |
| | A1.2 Pre-development agricultural value of land | X | |
| | A1.3 Vulnerability of land to flooding | X | |
| | A1.4 Potential for development to contaminate nearby bodies of water | X | |
| | A1.5 Pre-development contamination status of land | X | |
| | A1.6 Proximity of site to public transportation | X | |
| | A1.7 Distance between site and centres of employment or residential occupancies | X | |
| | A1.8 Proximity to commercial and cultural facilities | X | |
| | A1.9 Proximity to public recreation areas and facilities | X | |
| | **A2 - Project Planning** | | |
| | A2.1 Feasibility of use of renewables | X | |
| | A2.2 Use of Integrated Design Process | X | |
| | A2.3 Potential environmental impact of development or re-development | X | |
| | A2.4 Provision of surface water management system | X | |
| | A2.5 Availability of potable water treatment system | X | |
| | A2.6 Availability of a split grey/potable water system | X | |
| | A2.8 Composting and reuse of sludge in the community or project | X | |
| | A2.7 Collection and recycling of solid wastes in the community or project | X | |
| | A2.9 Site orientation to maximize passive solar potential | X | |
| | **A3 - Urban Design and Site Development** | | |
| | A3.1 Development density | X | |
| | A3.2 Provision of mixed uses within the project | X | |
| | A3.3 Encouragement of walking | X | |
| | A3.4 Support for bicycle use | X | |
| | A3.5 Policies governing use of private vehicles | X | |
| | A3.6 Provision of project green space | X | |
| | A3.7 Use of native plantings | X | |
| | A3.8 Provision of trees with shading potential | | X |
| | A3.9 Development or maintenance of wildlife corridors | X | |
| M | **B - ENERGY AND RESOURCE CONSUMPTION** | | |
| M | **B1 - Total Life Cycle Non-Renewable Energy** | | |
| | B1.1 Annualized non-renewable primary energy embodied in construction materials | X | |
| M | B1.2 Annual non-renewable primary energy used for facility operations | X | |
| | **B2 - Electrical peak demand for facility operations** | X | |
| M | **B3 - Renewable Energy** | | |
| | B3.1 Use of off-site energy that is generated from renewable sources | X | |
| M | B3.2 Provision of on-site renewable energy system | X | |
| | **B4 - Materials** | | |
| | B4.1 Re-use of suitable existing structure(s) | X | |

| | | | |
|---|---|---|---|
| | B4.2 Minimal use of finishing materials | X | |
| | B4.3 Minimal use of virgin materials | X | |
| | B4.4 Use of durable materials | X | |
| | B4.5 Re-use of salvaged materials | | X |
| | B4.6 Use of recycled materials from off-site sources | | X |
| | B4.7 Use of bio-based products obtained from sustainable sources | | |
| | B4.8 Use of cement supplementing materials in concrete | | X |
| | B4.9 Use of materials that are locally produced | X | |
| | B4.10 Design for disassembly, re-use or recycling | X | |
| M | **B5 - Potable Water** | | |
| | B5.1 Use of potable water for site irrigation | X | |
| | B5.2 Use of potable water for occupancy needs | X | |
| | B5.3 | | |
| M | **C - ENVIRONMENTAL LOADINGS** | | |
| M | **C1 - Greenhouse Gas Emissions** | | |
| | C1.1 Annualized GHG emissions embodied in construction materials | X | |
| M | C1.2 Annual GHG emissions from all energy used for facility operations | X | |
| | C1.3 | | |
| | **C2 - Other Atmospheric Emissions** | | |
| M | C2.1 Emissions of ozone-depleting substances during facility operations | X | |
| M | C2.2 Emissions of acidifying emissions during facility operations | X | |
| | C2.3 Emissions leading to photo-oxidants during facility operations | X | |
| | **C3 - Solid Wastes** | | |
| | C3.1 Solid waste resulting from the construction and demolition process | X | |
| | C3.2 Solid waste resulting from facility operations | X | |
| | **C4 - Rainwater, Stormwater and Wastewater** | | |
| | C4.1 Liquid effluents from facility operations sent off the site | X | |
| | C4.2 Retention of rainwater for later re-use | X | |
| | C4.3 Untreated stormwater retained in the site | X | |
| | C4.4 | | |
| | **C5 - Impacts on Site** | | |
| | C5.1 Impact of construction process on natural features of the site | X | |
| | C5.2 Impact of construction process or landscaping on soil erosion | X | |
| | C5.3 Changes in biodiversity on the site | X | |
| | C5.4 Adverse wind conditions at grade around tall buildings | X | |
| | C5.5 Minimizing danger of hazardous waste on site | X | |
| | **C6 - Other Local and Regional Impacts** | | |
| | C6.1 Impact on access to daylight or solar energy potential of adjacent property | X | |
| | C6.2 Cumulative thermal changes to lake water or sub-surface aquifers | X | |
| | C6.3 Heat Island Effect - landscaping and paved areas | X | |
| | C6.4 Heat Island Effect - roofing | X | |
| | C6.5 Atmospheric light pollution | X | |
| | C6.6 | | |
| | C6.7 | | |
| M | **D - Indoor Environmental Quality** | | |
| M | **D1 - Indoor Air Quality** | | |
| | D1.1 Protection of materials during construction phase | X | |

| | | | |
|---|---|---|---|
| | D1.2 Removal, before occupancy, of pollutants emitted by new interior finish materials | X | |
| | D1.3 Off-gassing of pollutants from interior finish materials | | X |
| | D1.4 Pollutant migration between occupancies | X | |
| | D1.5 Pollutants generated by facility maintenance | X | |
| | D1.6 Pollutants generated by occupant activities | X | |
| | D1.7 CO2 concentrations in indoor air | X | |
| | D1.8 IAQ monitoring during project operations | X | |
| M | **D2 - Ventilation** | | |
| M | D2.1 Effectiveness of ventilation in naturally ventilated occupancies | X | |
| M | D2.2 Air quality and ventilation in mechanically ventilated occupancies | | X |
| | D2.3 Air movement in mechanically ventilated occupancies | X | |
| | D2.4 Effectiveness of ventilation in mechanically ventilated occupancies | X | |
| | **D3 - Air Temperature and Relative Humidity** | | |
| | D3.1 Air temperature and relative humidity in mechanically cooled occupancies | X | |
| | D3.2 Air temperature in naturally ventilated occupancies | X | |
| | **D4 – Day-lighting and Illumination** | | |
| M | D4.1 Day-lighting in primary occupancy areas | X | |
| | D4.2 Glare in non-residential occupancies | X | |
| | D4.3 Illumination levels and quality of lighting | X | |
| | **D5 - Noise and Acoustics** | | |
| | D5.1 Noise attenuation through the exterior envelope | X | |
| | D5.2 Transmission of facility equipment noise to primary occupancies | X | |
| | D5.3 Noise attenuation between primary occupancy areas | X | |
| | D5.4 Acoustic performance within primary occupancy areas | X | |
| | **D6 -** | | |
| | **E - Service Quality** | | |
| | **E1 - Safety and Security During Operations** | | |
| | E1.1 | | |
| | E1.2 | | |
| | E1.3 | | |
| | E1.4 | | |
| | E1.5 | | |
| | E1.6 Maintenance of core building functions during power outlages | X | |
| | E1.7 | | |
| | E1.8 | | |
| | **E2 - Functionality and efficiency** | | |
| | E2.1 | | |
| | E2.2 | | |
| | E2.3 | | |
| | E2.4 | | |
| | E2.5 Spatial efficiency | X | |
| | E2.56 Volumetric efficiency | X | |
| | **E3 - Controllability** | | |
| | E3.1 Provision and operation of an effective facility management | X | |
| | E3.2 Capability for partial operation of facility technical systems | X | |
| | E3.3 Degree of local control of lighting system in non-residential occupancies | X | |
| | E3.4 Degree of personal control of technical systems by occupants | X | |

| | | | |
|---|---|---|---|
| | **E4 - Flexibility and Adaptability** | | |
| | E4.1 Ability to modify facility technical systems | X | |
| | E4.2 Adaptability constraints imposed by structure | X | |
| | E4.3 Adaptability constraints imposed by floor-to-floor heights | X | |
| | E4.4 Adaptability constraints imposed by building envelope and technical systems | X | |
| | E4.5 Adaptability to future changes in type of energy supply | X | |
| | **E5 - Commissioning of facility systems** | X | |
| | **E6 - Maintenance of Operating Performance** | | |
| | E6.1 Maintenance of building envelope performance | X | |
| | E6.2 Use of durable materials | X | |
| | E6.3 Development and implementation of a maintenance management plan | X | |
| | E6.4 On-going monitoring and verification of performance | X | |
| | E6.5 Retention of as-built drawings and documentation | X | |
| | E6.6 Provision and maintenance of a building log | X | |
| | E6.7 Performance incentives in leases or sales agreements | X | |
| | E6.8 Skills and knowledge of operating staff | X | |
| | **F - Social and Economic aspects** | | |
| | **F1 - Social Aspects** | | |
| | F1.1 Minimization of construction accidents | X | |
| | F1.2 Access for physically handicapped persons | X | |
| | F1.3 Access to direct sunlight from living areas of dwelling units | X | |
| | F1.4 Access to private open space from dwelling units | X | |
| | F1.5 Visual privacy from the exterior in principal areas of dwelling units | X | |
| | F1.6 Access to views from work areas | X | |
| | F1.7 Social utility of primary building function | X | |
| | **F2 - Cost and Economics** | | |
| | F2.1 Minimization of life-cycle cost | X | |
| | F2.2 Minimization of construction cost | X | |
| | F2.3 Minimization of operating and maintenance cost | X | |
| | F2.4 Affordability of residential rental or cost levels | X | |
| | F2.5 Support of Local Economy | X | |
| | F2.6 | | |
| | **G - Cultural and Perceptual Aspects** | | |
| | **G1 - Culture & Heritage** | | |
| | G1.1 Relationship of design with existing streetscapes | X | |
| | G1.2 Compatibility of urban design with local cultural values | X | |
| | G1.3 Maintenance of heritage value of existing facility | X | |
| | **G2 -** | | |
| | G2.1 | | |
| | G2.2 | | |
| | G2.3 | | |

**Table 11.2: The LEED for homes criteria**

| Credits available | CRITERIA | Type of requirement | |
|---|---|---|---|
| | | on/off | rating |
| | **Sustainable Sites** | | |
| **1** | LEED Certified Design and Construction | | x |
| **1** | Building Exterior and Hardscape Management Plan | | x |
| **1** | Integrated Pest Mgmt, Erosion Control, and Landscape Mgmt Plan | | x |
| **1 a 4** | Alternative Commuting Transportation | | x |
| | ***1*** 10% Reduction | | x |
| | ***1*** 25% Reduction | | x |
| | ***1*** 50% Reduction | | x |
| | ***1*** 75% Reduction or greater | | x |
| **1** | Reduced Site Disturbance, Protect or Restore Open Space | | x |
| **1** | Stormwater Management | | x |
| **1** | Heat Island Reduction, Non-Roof | | x |
| **1** | Heat Island Reduction, Roof | | x |
| **1** | Light Pollution Reduction | | x |
| | **Water Efficiency** | | x |
| **Required** | Minimum Indoor Plumbing Fixture & Fitting Efficiency | x | |
| **1** | Water Performance Measurement, Whole Building Metering | | x |
| **1** | Water Performance Measurement, Submetering | | x |
| **1 a 3** | Additional Indoor Plumbing Fixture and Fitting Efficiency | | x |
| | ***1*** 10% Reduction | | x |
| | ***1*** 20% Reduction | | x |
| | ***1*** 30% Reduction | | x |
| **1 a 3** | Water Efficient Landscaping | | x |
| | ***1*** 50% Reduction | | x |
| | ***1*** 75% Reduction | | x |
| | ***1*** 100% Reduction | | x |
| **1** | Cooling Tower Water Mgmt, Chemical Management | | x |
| **1** | Cooling Tower Water Mgmt, Non-Potable Water Source Use | | x |
| | **Energy & Atmosphere** | | |
| **Required** | Energy Efficiency Best Management Practices | x | |
| **Required** | Minimum Energy Efficiency Performance | x | |
| **Required** | Refrigerant Management, Ozone Protection | x | |
| **1 a 15** | Optimize Energy Efficiency Performance | | x |
| **Required** | ENERGY STAR Rating: 65 / Alternative Score: 15% Above Nat'l Average | x | |
| | ***1*** ENERGY STAR 67 / Alternative Score: 17% Above Average | | x |
| | ***1*** ENERGY STAR 69 / Alternative Score: 19% Above Average | | x |
| | ***1*** ENERGY STAR 71 / Alternative Score: 21% Above Average | | x |

| | | | | |
|---|---|---|---|---|
| | *1* | ENERGY STAR 73 / Alternative Score: 23% Above Average | | x |
| | *1* | ENERGY STAR 75 / Alternative Score: 25% Above Average | | x |
| | *1* | ENERGY STAR 77 / Alternative Score: 27% Above Average | | x |
| | *1* | ENERGY STAR 79 / Alternative Score: 29% Above Average | | x |
| | *1* | ENERGY STAR 81 / Alternative Score: 31% Above Average | | x |
| | *1* | ENERGY STAR 83 / Alternative Score: 33% Above Average | | x |
| | *1* | ENERGY STAR 85 / Alternative Score: 35% Above Average | | x |
| | *1* | ENERGY STAR 87 / Alternative Score: 37% Above Average | | x |
| | *1* | ENERGY STAR 89 / Alternative Score: 39% Above Average | | x |
| | *1* | ENERGY STAR 91 / Alternative Score: 41% Above Average | | x |
| | *1* | ENERGY STAR 93 / Alternative Score: 43% Above Average | | x |
| | *1* | ENERGY STAR 95+ / Alternative Score: 45%+ Above Average | | x |
| | **Energy & Atmosphere, continued** | | | |
| | Existing Building Commissioning | | | x |
| | *2* | Investigation and Analysis | | x |
| | *2* | Implementation | | x |
| | *2* | Ongoing Commissioning | | x |
| | Performance Measurement | | | |
| | *1* | Building Automation System | | x |
| **1 a 2** | System Level Metering | | | x |
| | *1* | 40% Metered | | x |
| | *1* | 80% Metered | | x |
| | Other | | | |
| **1 a 4** | Renewable Energy | | | x |
| | *1* | On-site 3% / Off-site 25% | | x |
| | *1* | On-site 6% / Off-site 50% | | x |
| | *1* | On-site 9% / Off-site 75% | | x |
| | *1* | On-site 12% / Off-site 100% | | x |
| **1** | Refrigerant Management | | | x |
| **1** | Emissions Reduction Reporting | | | x |
| | **Materials & Resources** | | | |
| **Required** | Sustainable Puchasing Policy | | x | |
| **Required** | Solid Waste Management Policy | | x | |
| **1 a 3** | Sustainable Purchasing | | | x |
| | *1* | 40% of Purchases | | x |
| | *1* | 60% of Purchases | | x |
| | *1* | 80% of Purchases | | x |
| **1** | Durable Goods, Electric | | | x |
| **1** | Durable Goods, Furniture | | | x |
| **1** | Facility Alterations and Additions | | | x |

| | | | |
|---|---|---|---|
| **1 a 2** | Reduced Mercury in Lamps | | x |
| | ***1*** 90 pg/lum-hr | | x |
| | ***1*** 70 pg/lum-hr | | x |
| **1** | Food | | x |
| **1** | Solid Waste Management | | x |
| **1** | Waste Stream Audit | | x |
| **1 a 2** | Ongoing Consumables | | x |
| | ***1*** 50% Waste Diversion | | x |
| | ***1*** 70% Waste Diversion | | x |
| **1** | Durable Goods | | x |
| **1** | Facility Alterations and Additions | | x |
| | **Indoor Environmental Quality** | | |
| **Required** | Outdoor Air Introduction and Exhaust Systems | x | |
| **Required** | Environmental Tobacco Smoke (ETS) Control | x | |
| **Required** | Green Cleaning Policy | x | |
| **1 a 5** | IAQ Management Program | | x |
| | ***1*** IAQ Management Program | | x |
| | ***1*** Outdoor Air Delivery Monitoring | | x |
| | ***1*** Increased Ventilation | | x |
| | ***1*** Reduce Particulates in Air Distribution | | x |
| | ***1*** Facility Alterations and Additions | | x |
| | Occupant Comfort | | x |
| | ***1*** Occupant Survey | | x |
| | ***1*** Occupant Controlled Lighting | | x |
| | ***1*** Thermal Comfort Monitoring | | x |
| | ***1*** Daylight and Views | | x |
| | ***1*** 50% Daylight / 45% Views | | x |
| | ***1*** 75% Daylight / 90% Views | | x |
| | Green Cleaning | | x |
| | ***1*** High Performance Cleaning Program | | x |
| | ***1*** Custodial Effectiveness Assessment | | x |
| | ***1*** Score of ≤ 3 | | x |
| | ***1*** Score of ≤ 2 | | x |
| | Sustainable Cleaning Products and Materials | | x |
| | ***1*** 30% of Purchases | | x |
| | ***1*** 60% of Purchases | | x |
| | ***1*** 90% of Purchases | | x |
| **1** | Sustainable Cleaning Equipment | | x |
| **1** | Entryway Systems | | x |
| **1** | Indoor Integrated Pest Management | | x |

| | | | |
|---|---|---|---|
| | **Innovation in Operations** | | |
| **1** | Voice and Data Distribution Systems: Reduction of Materials and Waste | | x |
| **1** | Building Materials: Reduce Building Height and Construction Materials | | x |
| **1** | Elimination of Carpet Waste | | x |
| **1** | Elimination of Suspended Ceilings | | x |
| **1** | LEED® Accredited Professional | | x |
| **2** | Documenting Sustainable Building Cost Impacts | | x |

**Table 11.3: the CASBEE for Home (Detached House) (2007 edition) criteria**

| QH | Environmental Quality of the Building |
|---|---|
| QH1 | Comfortable, Healthy and Safe Indoor Environment |
| 1 | Heating and Cooling |
| 1,1 | Basic performance |
| 1.1.1 | Ensuring thermal insulation and airtightness performance |
| 1.1.2 | Sunlight adjustment capability |
| 1,2 | Preventing summer heat |
| 1.2.1 | Allowing breezes in and heat out |
| 1.2.2 | Proper planning for cooling |
| 1,3 | Preventing winter cold |
| 1.3.1 | Proper planning for heating |
| 2 | Health, Safety and Security |
| 2,1 | Countermeasures against chemical contaminants |
| 2,2 | Proper planning for ventilation |
| 2,3 | Precautions against crime |
| 3 | Brightness |
| 3,1 | Use of daylight |
| 4 | Quietness |
| QH2 | Ensuring a Long Service Life |
| 1 | Basic Life Performance |
| 1,1 | Building frames |
| 1,2 | Exterior wall materials |
| 1,3 | Roof materials/flat roof |
| 1,4 | Resistance against natural disasters |
| 1,5 | Fire preparedness |
| 1.5.1 | Fire-resistant structure (excluding openings) |
| 1.5.2 | Early detection of fire |
| 2 | Maintenance |
| 2,1 | Ease of maintenance |
| 2,2 | Maintenance system |

| | |
|---|---|
| **3** | **Functionality** |
| 3,1 | Size and layout of rooms |
| 3,2 | Barrier-free design |
| **QH3** | **Creating a Richer Townscape and Ecosystem** |
| **1** | **Consideration of the Townscape and Landscape** |
| **2** | **Creating the Biological Environment** |
| 2,1 | Greening of the premises |
| 2,2 | Ensuring the biological habitat |
| **3** | **Safety and Security of the Region** |
| **4** | **Utilizing Regional Resources and Inheriting the Regional Housing Culture** |
| **LRH** | **Environmental Load Reduction of the Building** |
| **LRH1** | **Conserving Energy and Water** |
| **1** | **Energy Saving through Building Innovation** |
| 1,1 | Control of thermal load of building |
| 1,2 | Natural energy use |
| **2** | **Energy Saving through Equipment Performance** |
| 2,1 | Air-conditioning systems |
| 2.1.1 | Heating system |
| 2.1.2 | Cooling system |
| 2,2 | Hot-water equipment |
| 2.2.1 | Hot-water supply equipment |
| 2.2.2 | Heat insulation of bathtub |
| 2.2.3 | Hot-water plumbing |
| 2,3 | Lighting fixtures, home electric appliances and kitchen equipment |
| 2,4 | Ventilation system |
| 2,5 | Highly energy-efficient equipment |
| 2.5.1 | Home cogeneration system |
| 2.5.2 | Solar power generation system |
| **3** | **Water Conservation** |
| 3,1 | Water-saving systems |
| 3,2 | Rainwater use |
| **4** | **Well-Informed Maintenance and Operation Schemes** |
| 4,1 | Presentation of lifestyle advice |
| 4,2 | Management and control of energy |
| **LRH2** | **Using Resources Sparingly and Reducing Waste** |
| **1** | **Introduction of Materials Useful for Resource Saving and Waste Prevention** |
| 1,1 | Building frames |
| 1.1.1 | Wooden house |
| 1.1.2 | Steel-frame house |
| 1.1.3 | Concrete house |
| 1,2 | Ground-reinforcing materials, foundation work and foundations |

| | |
|---|---|
| 1,3 | Exterior materials |
| 1,4 | Interior materials |
| 1,5 | Materials for the external area |
| **2** | **Reduction of Waste in the Production and Construction Stages** |
| 2,1 | Production stage (members for building frames) |
| 2,2 | Production stage (members other than those for building frames) |
| 2,3 | Construction stage |
| **3** | **Promotion of Recycling** |
| 3,1 | Provision of information on materials used |
| **LRH3** | **Consideration of the Global, Local and Surrounding Environment** |
| **1** | **Consideration of Global Warming** |
| **2** | **Consideration of the Local Environment** |
| 2.1 | Control of the burden on the local infrastructure |
| 2.2 | Preservation of the existing natural environment |
| **3** | **Consideration of the Surrounding Environment** |
| 3.1 | Reduction of noise, vibration, exhaust and exhaust heat |
| 3.2 | Improvement of the thermal environment of the surrounding area |

**Table 11.4: The issues taken into account by the Code for Sustainable Homes**

| Categories | Issues |
|---|---|
| Energy and $CO_2$ emissions | Dwelling emission rate (M)<br>Building fabric<br>Internal lighting<br>Drying space<br>Energy labelled white goods<br>External lighting<br>Low or Zero Carbon (LZC) technologies<br>Cycle storage<br>Home office |
| Water | Internal water use (M)<br>External water use |
| Materials | Environmental impact of materials (M)<br>Responsible sourcing of materials – building elements<br>Responsible sourcing of materials – finishing elements |
| Surface water run-off | Management of surface water run-off from developments (M)<br>Flood risk |
| Waste | Storage of non-recyclable waste and recyclable household waste (M)<br>Construction waste management (M)<br>Composting |

| | |
|---|---|
| Pollution | Global Warming Potential (GWP) of insulants<br>$NO_x$ emissions |
| Health and wellbeing | Daylighting<br>Sound insulation<br>Private space<br>Lifetime homes (M) |
| Management | Home user guide<br>Considerate constructors scheme<br>Construction site impacts<br>Security |
| Ecology | Ecological value of site<br>Ecological enhancement<br>Protection of ecological features<br>Change in ecological value of site<br>Building footprint |

**Table 11.5: The Swan-labelling of Small houses criteria**

| Mandatory or Point score requirement | CRITERIA | Type of requirement | |
|---|---|---|---|
| | | on/off | rating |
| m | General description of the house | x | |
| m | Responsibility of the building process | x | |
| | **2 - Energy and ventilation** | | |
| m | Surface heat loss coefficient | | x |
| m | Relative power loss factor | | x |
| m | Ventilation | | x |
| m | Energy labelled white goods | x | |
| P | Reduced relative power loss factor | | x |
| p | Low-flow showers and basin mixer taps | x | |
| | **3 - Material requirements** | | |
| m | List of products/materials | x | |
| m | Chemical products, safety data sheets | x | |
| m | Indoor paint, varnish and floor oil | x | |
| m | Adhesive (only adhesive for indoor use) | x | |
| m | Filler, floor, screed/liquid filler, filler/sealant | | x |
| m | Sustainable forestry | x | |
| m | Timber from certified forest, conditional agreement | | x |
| p | use of more than 30% timber from certified forestry | | |

| | | | |
|---|---|---|---|
| m | classification of chemical products, wood preserving (impregnation) | x | |
| m | active substance in impregnated wood | x | |
| m | Formaldehyde emissions | | x |
| m | permanent sealants | x | |
| p | use of ecolabelled products | x | |
| m | Thermal insulation material, flame retardants | x | |
| m | Thermal insulation material, propellants | x | |
| m | Thermal insulation material, cancer classification | x | |
| m | Lead | x | |
| m | Plastic for interior flooring, wall coverings and ceilings | x | |
| m | plastic in windows | | x |
| m | additives in plastic products | x | |
| p | halogen-free plastic products (free from chlorine and bromine) | x | |
| p | chlorine-free coverings in wet rooms | x | |
| m | low-flush toilets | x | |
| p | waste sorting container for household waste | x | |
| | **4 - Quality management and control for the building process** | | |
| m | Radon | | x |
| m | Material requirements | x | |
| m | Waste management on the building site | x | |
| m | Moisture in wooden structures | x | |
| m | Handling and storage of materials on the building site | x | |
| m | pre-inspection and final inspection | x | |
| p | waste sorting | x | |
| m | quality control | x | |
| m | moisture control in concrete slabs | x | |
| m | building's airtightness (at 50 Pa pressure difference) | | x |
| m | training | x | |
| m | customer information | x | |
| m | laws and regulations | x | |
| m | organisation and responsibility | x | |
| m | changes and nonconformities | x | |
| m | complaints | x | |
| m | traceability | x | |
| m | documentation of the application | x | |
| m | marketing | x | |
| | **5 - Instructions for residents** | | |
| m | maintenance plan | x | |
| m | information on materials | x | |
| m | information on the indoor climate | x | |

| | | | |
|---|---|---|---|
| m | manual for heating and ventilation systems | x | |
| m | ventilation ducts | x | |

**Table 11.6: The Haute Qualité Environnementale (HQE) criteria**

| Credits available | CRITERIA | | Type of requirement | |
|---|---|---|---|---|
| | | | on/off | rating |
| Base/Performant o 1/3 | Ecoconstruction | | | |
| 1 | Relation harmonieuse du bâtiment avec son environnement immédiat | | x | |
| | | Aménagement de la parcelle pour un développement durable | x | |
| | | Qualité d'ambiance des espaces extérieurs pour les usagers | x | |
| | | Impact du bâtiment sur le voisinage | x | |
| | | exigences minimales | x | |
| | | Données sur le site | x | |
| | | Autres données environnementales et évolutions prévisibles | | x |
| | | Risques technologiques | | x |
| | | Ressources locales et évolutions prévisibles | | x |
| 1 | Choix intégré des procédés et produits de construction | | x | |
| | | Choix constructifs pour la durabilité et l'adaptabilité de l'ouvrage | x | |
| | | Choix constructifs pour la facilité d'entretien de l'ouvrage | x | |
| | | Choix des produits de construction, afin de limiter les impacts environnementaux de l'ouvrage | x | |
| | | Choix des produits de construction, afin de limiter les impacts sanitaires | x | |
| | | exigences minimales | x | |
| 1 | Chantier à faibles nuisances | | | x |
| | | Optimisation de la gestion des déchets de chantier | | x |
| | | Réduction des nuisances, pollutions et consommations de ressources engendrées par le chantier | | x |
| | | exigences minimales | | x |
| Performant | Ecogestion | | | |
| 1 | Gestion de l'énergie | | | |
| | | Réduction de la demande énergétique par la conception architecturale | x | |
| | | Réduction de la consommation d'énergie primaire et des pollutions associées | x | |
| | | Réduire la consommation d'énergie primaire due au chauffage, au refroidissement, à l'éclairage, à l'ECS, à la ventilation, et aux auxiliaires de fonctionnement | x | |
| | | Limiter les pollutions générées par la consommation | x | |

| | | | | |
|---|---|---|---|---|
| | | d'énergie | | |
| | | Utiliser des énergies renouvelables locales | x | |
| | exigences minimales | | | |
| | | renforcer l'efficacité énergétique des projets | x | |
| | | choisir des chaudières « propres » labellisées à faible émission de CO2. | x | |
| **1** | Gestion de l'eau | | | |
| | | Réduction de la consommation d'eau potable | x | |
| | | Optimisation de la gestion des eaux pluviales | x | |
| | | exigences minimales | x | |
| **1** | Gestion des déchets d'activités | | | |
| | | Optimisation de la valorisation des déchets d'activité | x | |
| | | Qualité du système de gestion des déchets d'activité | x | |
| | | exigences minimales | x | |
| **1** | Gestion de l'entretien et de la maintenance | | | |
| | | Maintien des performances des systèmes de chauffage et de rafraichissement | x | |
| | | Maintien des performances des systèmes de ventilation | x | |
| | | Maintien des performances des systèmes d'éclairage | x | |
| | | Maintien des performances de gestion de l'eau | x | |
| **Performant** | **Création d'un environnement intérieur satisfaisant** | | | |
| **1** | Confort hygrothermique | | | |
| | | Dispositions architecturales visant à optimiser le confort hygrothermique en hiver et en été | | x |
| | | Création de conditions de confort hygrothermique en hiver | | x |
| | | Création de conditions de confort hygrothermique en été dans les locaux n'ayant pas recours à un système de refroidissement | | x |
| | | Création de conditions de confort hygrothermique en été dans les locaux ayant recours à un système de refroidissement | | x |
| | | exigence minimale | | |
| **1** | Confort acoustique | | | |
| | | Optimisation des dispositions architecturales | x | |
| | | Création d'une qualité d'ambiance acoustique adaptée aux différents locaux | | x |
| | | exigence minimale | | x |
| **1** | Confort visuel | | | |
| | | Assurance d'un éclairement naturel optimal, tout en évitant ses inconvéniants (éblouissement) | | x |
| | | Eclairage artificiel confortable | | x |
| | | exigences minimales | | |
| **1** | Confort olfactif | | | |
| | | Garantie d'une ventilation efficace ; | | x |
| | | Maîtrise des sources d'odeurs désagréables | | x |
| **Base** | **Santé** | | | |

| | | | | |
|---|---|---|---|---|
| 1 | Qualité sanitaire des espaces | | x | |
| | | exigences minimales : | x | |
| 1 | Qualité sanitaire de l'air | | x | |
| | | exigences minimales | x | |
| 1 | Qualité sanitaire de l'eau | | x | |
| | | exigences minimales | x | |

**Table 11.7: The klima:aktiv criteria**

| Mandatory | Credits available | | CRITERIA |
|---|---|---|---|
| | | A | **Design and Execution** |
| | | A.1 | **Design** |
| | 20 | A.1.1 | Infrastructure |
| | 30 | A.1.2 | Parking space for bikes |
| | 20 | A.1.3 | Barrier free Building (partial/complete) |
| | 20 | A.1.4 | Building envelope (attention to thermal bridges) |
| | | A.2 | **Execution** |
| M | 25 | A.2.1 | Building envelope airtight |
| | 15 | A.2.2 | Building envelope airtight (Passivhaus) |
| | | B | **Energy and Supply** |
| | | B.1 | **Heat demand and supply** |
| M | 575 | B.1.1b | Passivhaus (PHPP) |
| | | B.2 | **Energydemand (electrical)** |
| M | 20 | B.2.1 | Ventilation system (energy efficient) |
| | 10 | B.2.2 | Lightning (energy efficient) |
| | 10 | B.2.3 | Laundry and dishes with connection hot water |
| | 35 | B.2.4 | Photovoltaic |
| | | B.3 | **Water demand** |
| M | 20 | B.3.1 | Fittings: water saving (standard) |
| | 10 | B.3.2 | Handwashbasin water saving (optimised) |
| | 10 | B.3.3 | Showerhead water saving (optimised) |
| | | C | **Materials and Construction** |
| | | C.1 | **Materials** |
| M | 20 | C.1.1 | Insulation material HFKW free |
| | 40 | C.1.2 | Windows, doors, shutters PVC free |
| M | 40 | C.1.3 | Tubes, foils, flooring, wall paper PVC free |
| | 10 | C.1.4 | Bitumen coating, adhesives solvent-free |
| | 40 | C.1.5 | Material ecologically optimised |

| | | | |
|---|---|---|---|
| | | C.2 | Construction and Building |
| | 100 | C.2.1 | Ecological Index of the Building envelope - OI3TGH, BGF |
| | | D | Comfort and Indoor Air-quality |
| | | D.1 | Thermal Comfort |
| M | 30 | | Summer proof |
| | | D.2 | Indoor Air-quality |
| M | 60 | | Ventilation system optimised (sound etc.) |
| | 10 | | Pasting material low-emission |
| | 15 | | Flooring emission-free |
| | 15 | | Timber products low-emission |
| | 10 | | Coating of wall and ceiling low-emission |
| | 25 | | Measurement of VOC and formaldehyde |

**Table 11.8: The ITACA criteria**

| CRITERIA | Type of requirement | |
|---|---|---|
| | on/off | rating |
| **1- Outdoor environmental quality** | | |
| **1.1 - outdoor environmental comfort** | X | |
| 1.1.1- outside heat-comfort | X | |
| 1.1.2- air flow control | X | |
| 1.1.3- visual and perceptual comfort | X | |
| **1.2 - local pollution** | | |
| 1.2.1- noise pollution | X | |
| 1.2.2- air pollution | X | |
| 1.2.3- electromagnetic pollution | X | |
| 1.2.3.1- electromagnetic pollution to low frequency | X | |
| 1.2.3.2- electromagnetic pollution to high frequency | X | |
| 1.2.4- soil pollution | X | |
| 1.2.5- water pollution | X | |
| 1.2.6- light pollution | X | |
| **1.3 context integration** | | |
| 1.3.1- integration with natural environment | X | |
| 1.3.2- integration with built environment | X | |
| 1.3.3- infrastructural networks | X | |
| **2- Resource consumption** | | |
| **2.1- energy consumption** | | |
| 2.1.1- thermal insulation | X | |
| 2.1.2- passive solar system | X | |
| 2.1.3- water production | X | |
| 2.1.4- electric energy (non renewable source) | X | |

| | | |
|---|---|---|
| 2.1.5- feedstock energy | X | |
| **2.2- soil consumption and impact on ecologic quality** | | |
| 2.2.1- change of the ecologic value of the site | X | |
| **2.3- potable water consumption** | | |
| 2.3.1- potable water consumption | X | |
| **2.4- materials consumption** | | |
| 2.4.1- reuse of existent structures | X | |
| 2.4.2- reuse of materials that are present on the site | X | |
| 2.4.3- use of local/regional materials | X | |
| 2.4.4- use of recycled materials | X | |
| 2.4.5- recycling of materials | X | |
| 2.4.6- ecolabelling | X | |
| **3- environmental charge** | | |
| **3.1- gas emission reduction** | | |
| 3.1.1- CO2 emissions | X | |
| 3.1.2- gas emissions (SO2) | X | |
| **3.2- liquid wastes reduction** | | |
| 3.2.1- rain water management | X | |
| 3.2.2- reuse of greywater | X | |
| 3.2.3- ground permeability | X | |
| **3.3- solid built waste management** | | |
| 3.3.1- solid construction wastes | X | |
| 3.3.2- solid demolition wastes | X | |
| **3.4- waste management** | | |
| 3.4.1- non-organic waste separate collection area | X | |
| 3.4.2- organic waste separate collection area | X | |
| **3.5- impacts on site** | | |
| 3.5.1- impact on natural light | X | |
| 3.5.2- soil erosion | X | |
| **4- indoor air quality** | | |
| **4.1 - visual comfort** | | |
| 4.1.1- natural lighting | X | |
| 4.1.2- solar direct radiation | | X |
| 4.1.3- lighting uniformity | X | |
| 4.1.4- artificial lighting of common spaces | X | |
| **4.2- acoustic comfort** | | |
| 4.2.1- acoustic insulation for external vertical walls | X | |
| 4.2.2- acoustic insulation of internal walls | X | |
| 4.2.3- acoustic insulation for pattering noise and atmospheric agents | X | |
| 4.2.4- acoustic insulation of technical systems | X | |
| **4.3- heat comfort** | | |
| 4.3.1- air temperature during the winter | X | |
| 4.3.2- internal surfaces temperature during the winter | X | |
| 4.3.3- thermal inertia | X | |
| **4.4- air quality** | | |
| 4.4.1- humidity walls control | X | |

| | | |
|---|---|---|
| 4.4.2- pollution agents control | X | |
| 4.4.2.1- mineral fibre | X | |
| 4.4.2.2- VOC | X | |
| 4.4.2.3- radon | X | |
| 4.4.3- ventilation | X | |
| 4.4.3.1- air exchange | X | |
| 4.4.3.2- air exchange from areas without ventilation | X | |
| 4.4.4- electromagnetic pollution | X | |
| 4.4.3.1- electromagnetic fields to industrial frequency | X | |
| 4.4.3.2- electromagnetic fields to high frequency | X | |
| **5- service quality** | | |
| **5.1- built and plan design maintenance** | | |
| 5.1.1- envelop protection | X | |
| 5.1.2- envelop accessibility | X | |
| 5.1.3- thermal systems accessibility | X | |
| **5.2- consumptions monitoring** | X | |
| **5.3- common areas** | | |
| 5.3.1- common areas | X | |
| **5.4- live space quality** | | |
| 5.4.1- internal spaces flexibility | X | |
| **6- management quality** | | |
| **6.1- technical documentation of the building** | | |
| 6.1.1- technical documentation of the building | X | |
| **6.2- use manual** | | |
| **6.**2.1- use manual | X | |
| **6.3- programmed maintenance** | | |
| 6.3.1- programming of maintenance | X | |
| **6.4- building security** | | |
| 6.4.1- building security | X | |
| **7- transport** | | |
| **7.1- public transport integration** | | |
| 7.1.1-public transport integration | X | |
| **7.2- measure to implement alternative transport** | | |
| 7.2.1- measures to implement alternative transport ( bicycle parking and bicycle route) | X | |
| **7.3- proximity to local services** | | |
| 7.3.1- proximity to local services | X | |

**Table 11.9: The SB100 standard**

| CRITERIA | Type of requirement | |
|---|---|---|
| ECOLOGY | on/off | rating |
| 1. Energy | | |

| | | |
|---|---|---|
| location of the building depending on the terrain conformation or winds direction depending from the different seasons | x | |
| location of buildings depending on obstacles and obtrusions on the south (trees, adjacent buildings, other) | | x |
| guidance of the building depending on the solar geometries of the place | | x |
| energetic certification of winter consumption of the building measured in kWh/mq (SB100 indicator) | | x |
| passive behaviour of the building for winter conditioning depending on the ratio between shape and exposed surfaces | | x |
| passive behaviour of the building for winter conditioning with use of passive direct gain systems | | x |
| passive behaviour of the building for winter conditioning with use of solar greenhouses | | x |
| passive behaviour of the building the winter conditioning with use of walls, lofts and low transmittance covers for heat dispersals reduction | | x |
| passive behaviour of the building for winter conditioning with use of low transmittance doors and windows for heat dispersal reduction | | x |
| passive behaviour of the building for winter conditioning with use of solar collectors for the heat plant | | x |
| passive behaviour of the building for winter and summer conditioning with use of heat pump geothermal technologies | | x |
| passive behaviour of the building for winter conditioning and for production of electric energy with system of cogeneration, tri-generation or tele-heating | x | |
| active behaviour of the building for winter conditioning with use of high performance mixing or condensation boilers | | x |
| active behaviour of the building for winter conditioning with use of biomass, high performance and low emission boilers | x | |
| active behaviour of the building for winter conditioning utilizing low temperature radiators (on walls, floor, ceiling). | x | |
| active behaviour of the building for winter conditioning with use of controlled ventilation systems with heat recovery | x | |
| passive behaviour of the building for summer conditioning by thermal load reduction of external surfaces depending on their reflection coefficient (albedo) | | x |
| passive behaviour of the building for summer conditioning with use of natural and/or artificial systems of solar radiation control | | x |
| passive behaviour of the building for summer conditioning with use of housing high thermal wave lag stratigraphies | | x |
| passive behaviour of the building for summer conditioning with natural cooling determined by correct location of the building, dimensioning and disposition of windows, conducts and ventilation systems | | x |
| active behaviour of the building for summer conditioning with use of cooling radiators integrated with controlled dehumidification systems | x | |
| Reduction of not renewable energy consumptions for hot sanitary water with use of solar collectors | | x |
| Reduction of electric consumptions by dimensioning of windowed openings allowing an adequate average daylight factor and a uniform distribution of natural light | | x |
| Reduction of electric consumptions with low consumption and high efficiency systems with automatic activation, regulation and deactivation | x | |

| | | |
|---|---|---|
| Reduction of electric consumptions with use of photovoltaic systems for production of electric energy with renewable sources | | x |
| **2 WATER** | | |
| Drinking water saving systems for toilets | x | |
| Uptake, accumulation, filtering and distribution of rain water for secondary uses (not health and drinking) | x | |
| Recovery, depuration, accumulation and distribution of the grey waters for secondary uses (not health and drinking) | x | |
| Recovery, depuration, accumulation and distribution of black waters (not health and drinking) | x | |
| Drinking water saving systems for sanitary fittings | x | |
| Visible Accounting divided in functional unities of drinking water consumption measured in mc/ pro capite / year | x | |
| Permeability for the water of external surfaces | | x |
| **3. MATERIALS** | | |
| Building Recovery intervention functional to saving of materials and resources | | x |
| Use of materials with declaration of environmental quality | | x |
| Use of materials and building techniques allowing dry construction | | x |
| Use of materials made with renewable sources | | x |
| Uptake, accumulation, filtering and distribution of rain water for secondary uses (not health and drinking) | | x |
| Use of materials made with recycling processes preferably located in the nearing of building yards and reuse of technical elements coming from selective demolitions, sub products and residual materials | | x |
| Limitation of use of materials coming from petrochemical synthesis | | x |
| Use of locally available materials with low energetic deal for transport by control of the distances between the materials and the yard | | x |
| Use of materials with low incorporated energy with preference, with the same performance, to lower incorporated energy ones | | x |
| Use of materials and building techniques that require low energetic consumption during the construction phase | | x |
| Use of materials and building techniques that allow a low energetic consumption in the phase of management and maintenance of the building | | x |
| Use of long period featured materials | | x |
| **4. WASTE** | | |
| Building deconstruction plan with definition of times and modes of the operative sequences | x | |
| Use of recyclable materials for main uses, for secondary uses and/or composting | | x |
| Use of materials and construction techniques allowing selective demolition and energetic containment in phase of divestment / recycling | | x |
| Use of materials without packaging or using recoverable or recyclable distribution packages | | x |
| Use of materials and construction techniques allowing selective dismantle and materials recovery. | | x |
| Plan for yard waste management with identification of modes for separation and recycling | | x |
| Dimensioning and organization of spaces for separate waste collection of waste of the building according to its destination and to the number of users | x | |

| | | |
|---|---|---|
| **SOCIETY** | | |
| **1. HEALTH** | | |
| Radon presence measurement | x | |
| Solutions for radon control and disposal | x | |
| Safety distance from external electromagnetic low frequency (50 Hz) pollution sources proved by surveys with appropriate instrumentation | | x |
| Safety distance from external electromagnetic radiofrequency and microwaves (100 kHz-300 GHz) pollution sources proved by surveys with appropriate instrumentation | | x |
| Limitation of low (50 Hz) and high frequency (100 kHz-300 GHz) electric and magnetic fields in internal spaces | x | |
| CO2 emissions containment | x | |
| Concentrations of main air polluting substances | | x |
| Adoption of internal air recycled in the winter period | x | |
| Use of natural negative ionization systems for the internal air | x | |
| Safety distances from acoustic pollution sources | | x |
| Containment of noise from technological devices and sources of continuous and discontinuous type, as elevators, hydraulic discharges, bathrooms, hygienic services, taps | | x |
| Adoption of partitions with high phono-isolating power between spaces and distinct units and adequate distribution of internal spaces | | x |
| Adoption of isolated undercoats and/or floating floors and/or phono-isolating materials for the floor surface coating | | x |
| Direct sunshine of the locals that foresee presence of persons to promote health of sight and anti-bacteric action of solar light | | |
| Correct dimensioning and distribution of sources of natural light and systems of screening | x | |
| Uniformity of distribution of natural light in the spaces used during daylight | x | |
| Use of artificial light systems of adequate quantity and quality | | x |
| Use of materials with bio-housing certifications concerning health, a-toxicity and biological quality | | x |
| Use of materials with none or low radioactivity emission | | x |
| Use of materials with none or low emissions of VOCs | | x |
| Use of materials with none or low emission of steams, smells, dust, particles and micro-fibres and other polluting substances in phase of production, application and use | | x |
| **2. Comfort** | | |
| Absence of surface and interstitial condensate in the opaque housing | x | |
| Ensure an internal relative humidity rate in the range of comfort | x | |
| Ensure a high internal surface temperature of the opaque housing in the winter period. | | x |
| Ensure a high internal surface temperature of transparent closures in the winter period. | | x |
| Ensure high lag and mitigation values of the opaque housing in the summer period. | | |
| Use of green hanging solutions for roofing | x | |
| Ensure winter sunshine and summer shadow of outside spaces | | x |
| Use of materials with good insulating characteristics and acoustic absorption | | x |
| Use of materials with high steam permeability for the opaque housing of the building | | x |

| | | |
|---|---|---|
| Use of materials with good thermal insulating characteristics | | x |
| **3. Contest** | | |
| Protection and maintenance of the site, of the flora and fauna existing in the area | x | |
| Reduce terrain consumption | | x |
| Guarantee of sun exposure for the areas close to the building | x | |
| ease of access to essential social services | | x |
| Social features analysis of the area with particular reference to un-advantaged subjects and handicap bearers | x | |
| Ease of access to public transportation to promote sustainable mobility | | x |
| Sustainable mobility by facilitating use of non polluting transport (bycicle or similar) | x | |
| Safeguard of the pedestrian area in the surrounding of the building | x | |
| External light only in presence of proved necessity, with high efficient lighting devices with automatic regulation of the light intensity according to the effective nightly uses and low upwards light dispersion | x | |
| **ECONOMY** | | |
| **1. Info** | | |
| Arrangement of the building dossier with inclusion of the final SB100 tab | x | |
| arrangement of the use and programmed maintenance manual with inclusions of references to sustainability | x | |
| Availability of an informative system for integrated communication of energetic consumptions of the building, of comfort indicators, of management costs | x | |
| **2. Costs** | | |
| Writing of the list of works highlighting the specific qualities of construction systems and materials chosen according to the SB100 criteria for actions | x | |
| Evaluation of extra costs for innovative components and their depreciation times | x | |
| Evaluation of construction cost per mq. of the building and comparation with the market cost of a conventional action of the same quality | x | |
| **3. Management** | | |
| writing of the building programmed maintenance plan identifying and highlighting the performances of the building components | x | |
| writing an archive always available and easily understandable that collects the technical documentation of the building | x | |
| writing of the management costs evaluation per mq of the building and the times of depreciation of the extra-costs of the innovative components foreseeing the monitoring times SB100 | x | |

**Table 11.10: The LEnSE project criteria**

| CRITERIA | Intent | Potential indicators |
|---|---|---|
| **ENVIRONMENTAL** | | |
| **1. Climate Change** | | |
| Building - depletion of non renewable primary energy | Accounting for building related primary energy production and its environmental impact in terms of CO2 emissions and other greenhouse gas emissions. | ▫ Kg CO2/m2<br>▫ kWh/m2 |
| Transport - depletion of non renewable primary energy | Accounting for the buildings impact and influence on transport related greenhouse gas emissions as a result of its location. | ▫ KgCO2/person/year |
| Use of renewable primary energy | Accounting for primary energy demand met via renewable energy sources. | ▫ Percentage of primary energy use met via |
| Destruction of the stratospheric ozone layer | Accounting for the destruction of the ozone layer caused by the manufacture and emission of refrigerants and acidifying pollutants. | ▫ Global warming potential |
| Local tropospheric ozone formation | Accounting for the creation of low level ozone as a result of building related activities, for example Nox emissions from a buildings heating source. | ▫ NOx emission levels in mg/kWh |
| **2. Biodiversity** | | |
| Minimise point sources of eutrophication | Accounting for the building related point sources that contribute to the process of eutrophication. | ▫ Nitrogen/Nitrous Oxide to air/land |
| Land of low ecological value | Accounting for the ecological value of the land selected for development. | ▫ Number of existing ecologically valuable species and habitats. |
| Mitigating impact on existing site ecology | Accounting for the change in ecological value as a result of change in land use.. | ▫ Number of plant species. |
| Enhance native plant/animal species | Accounting for (and encouraging) the enhancement of a site as a result of development. | ▫ Number of plant species. |
| Habitat management/action plan | Accounting for (and encouraging) the ongoing | ▫ Best practice guidelines |
| **3. Resource use** | | |
| Depletion and use of renewable and non renewable resources (other than primary energy) | Accounting for the specification and life cycle impacts of the buildings materials and key building elements. | ▫ LCA performance of material/element |
| Responsible sourcing of materials | Accounting for the sourcing of materials such as timber, cement, aggregate, metals etc. | ▫ Certification schemes e.g. FSC, CSA, ISO |

| | | |
|---|---|---|
| Non hazardous waste disposal | Accounting for the non hazardous waste production. | ▫ Waste generation by volume m3/100m2<br>▫ % waste for key materials. |
| Hazardous waste to disposal | Accounting for hazardous waste production and disposal. | ▫ This issue requires further investigation to define a measurable for LEnSE. |
| Use of freshwater resources | Accounting for building occupants water consumption | ▫ m3/person/year |
| Re-use of previously developed sites | Accounting for unsustainable land use changes. | ▫ Percentage of the site previously developed. |
| Development footprint | Accounting for the sustainable use of land for building and associated infrastructure e.g. avoiding building 'sprawl' | ▫ Dwellings per hectare<br>▫ A ratio of no. of floors to building footprint |
| Contaminated land, bioremediation and soil re-use | Accounting for the sustainable benefits of contaminated land remediation. | ▫ Percentage of site contaminated<br>▫ Degree of contamination<br>▫ Level of bioremediation. |
| **4. Env. Management & Geophysical risk** | | |
| Certified Environmental Management System | Accounting for developers and building owners that have an appropriate management plan to mitigate organisational environmental impacts. | ▫ Certified EMS to ISO14001 EMAS |
| Minimising regional specific climatalogical risk | Accounting for country/region specific climatological impacts through building design, use and operation. | ▫ The measurable will be dependent on the relevant climatological risks in each country/region. |
| Minimising regional specific geophysical risk | Accounting for country/region specific geophysical impacts through building design, use and operation. | ▫ The measurable is dependent on the relevant geological risks in each country/region. |
| **SOCIAL** | | |
| **1. Occupant wellbeing** | | |
| Lighting comfort (artificial & natural) | Accounting for the contribution of daylight and adequate artificial lighting in creating a comfortable and productive internal environment for the building user. | ▫ Recommended maintained lighting levels (lux)<br>▫ Provision of daylight (average daylight factor) |
| Thermal comfort | Accounting for the integration and holistic consideration of factors that create thermally comfortable and productive internal environments | ▫ Degree and type of thermal comfort analysis carried out<br>▫ Performance standards for avoidance of overheating |
| Ventilation conditions | Accounting for ventilation rates in creating a comfortable and productive internal environment. | ▫ Litres of fresh air / second / person |
| Acoustic comfort | Accounting for acoustics in creating a comfortable & productive internal environment. Accounting for user experience in | ▫ Internal noise levels<br>▫ Reverberation times<br>▫ Sound insulation levels |

| | | |
|---|---|---|
| | creating a | |
| Occupant satisfaction | comfortable & productive internal environment. | ▫ Post completion monitoring<br>▫ Occupant satisfaction surveys. |
| Private space | Accounting for the provision of access to private space for building users/occupiers. | ▫ Proximity (m)<br>▫ Size (m2)<br>▫ Type/facilities |
| Outdoor space | Accounting for the provision of access to adequate external space e.g. gardens, parks, squares etc | ▫ Proximity (m)<br>▫ Size (m2)<br>▫ Type/facilities |
| Materials/substance exclusion | Accounting for the specification of materials that are potentially dangerous to health, ensuring they are minimised or excluded. | ▫ VOC levels<br>▫ Eco-labels<br>▫ Materials exclusion clauses |
| Indoor air quality | Accounting for and preventing high levels of internal pollutants and microbial contamination | ▫ CO2 levels (ppm) / ventilation controls<br>▫ Design of humidification systems<br>▫ Location of air intakes and extracts |
| Quality of drinking water | Minimising the risk of microbial water contamination such as legionella | ▫ Best practice design of domestic hot water system |
| Building safety assessment | Accounting for a buildings spatial arrangement, access and services on the grounds of safety. | ▫ This issue requires further investigation to define a measurable for LEnSE. |
| **2. Accessibility** | | |
| Key amenities - provision and proximity | Accounting for the provision of amenities and services within the locality of the building e.g. doctors, shop, playground. | ▫ Number/type of amenities/services<br>▫ Distance from building to amenities/services (m) |
| Public transport accessibility | Accounting for the buildings accessibility level to public transport networks. | ▫ Distance to transport node (m)<br>▫ No. of services and frequency (min) |
| Provision of safe and adequate pedestrian route ways | Accounting for adequate and safe pedestrian routes that provide priority for pedestrians and direct links to amenities. | ▫ Best practice design and specification |
| Provision of safe and adequate cycle lanes and cyclist facilities | Accounting for adequate and safe cycle paths that link up with external cycle route ways and onsite cyclist facilities. | ▫ Number of cycle racks & cyclist facilities<br>▫ Best practice design and specification |
| Provision of car pooling facilities | Accounting for policies that reduce reliance on the private motor vehicles and single occupant car journeys to work. | ▫ Car share spaces<br>▫ Parking charges |
| **3. Security** | | |
| Site security and spatial arrangement | Accounting for security and the adoption of effective crime prevention strategies in the design/operation of the building. | ▫ Third party assessment and evaluation to relevant standards |

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|---|---|---|
| Building security | Accounting for the security risk from building elements such as windows, doors and facades. | ▫ Specification of buildings elements designed and tested to a relevant security standard. |
| **4. Social and cultural value** | | |
| Community impact consultation | Accounting for consultation with the community and appropriate stakeholders on the design/use of the building and its role within the local community. | ▫ Multi-criteria analysis and evaluation |
| Social cost benefit analysis | Accounting for the local/regional social case for the building and its social benefits and costs. | Multi-criteria analysis e.g.:<br>▫ Degree of social housing<br>▫ Health impact<br>▫ Job creation etc. |
| Socially responsible and ethical procurement of goods/services | Accounting for the ethical procurement of goods and services associated with the development/use of the building. | ▫ Evidence of purchasing policies |
| Considerate Constructors | Accounting for the consideration of the local environment/community during the construction phase. | ▫ Adoption of a code(s) of practice<br>Third party audit and certification |
| External 'neighbourhood' impacts | Accounting for the building's impacts that could cause a nuisance to surrounding buildings. For example: noise and light pollution, over-shadowing, lack of privacy. | Multi-criteria, e.g:<br>▫ Increase in background noise levels<br>▫ External lighting levels |
| Design quality | Accounting for the design quality of the building during the development of the initial brief through to detailed design. | ▫ Multi-criteria analysis via third party assessment process<br>▫ Adoption of relevant design codes. |
| **ECONOMIC** | | |
| **1. Financing and management** | | |
| Function analysis | Developing a systematic breakdown of the buildings functional requirement, concentrating on the actual needs, aspirations and wants of the client and project stakeholders. | ▫ This issue requires further investigation to define a measurable for LEnSE. |
| Risk & value management | Maximising building value and reducing risk by establishing a clear consensus about the project objectives and how they can be achieved. This sub issue is linked to the function analysis sub issue. | ▫ This issue requires further investigation to define a measurable for LEnSE. |
| **2. Whole life value** | | |
| Life Cycle Costs appraisal - Strategic level | Accounting for Life Cycle Costs of a building in a co-ordinated and standardised manner so that the information can be used to aid decision making concerning the | ▫ Net Present Value<br>▫ Internal rate of return<br>▫ Ratio of build: maintenance: staff costs |
| Life Cycle Costs appraisal - Component level | | |

| | | |
|---|---|---|
| | design options that provide best value. | |
| Option appraisal | Using multi criteria analysis, including risk and value management and LCC, to appraise design and make decisions based on best value and not just costs. | ▫ This issue requires further investigation to define a measurable for LEnSE. |
| Exchange value | Accounting for the buildings value and as a commodity to be traded. | ▫ Book value<br>▫ Return on capital |
| Added value | Accounting for the 'use value' to the building owner or occupier that arises from the process that building is built for and its contribution to organisational outcomes and repeat business. | Multi-criteria, examples may include;<br>▫ Total cost of occupancy vs. profitability<br>▫ Total cost of occupancy vs. exam results, recovery rates<br>▫ Operating costs per head,<br>▫ Absenteeism, staff turnover, staff satisfaction |
| Building adaptability | Accounting for flexibility of building infrastructure (services, IT, spatial design) that ensure connectivity and environmental quality through multiple organisational iterations. | ▫ Modular construction<br>▫ Wireless networks<br>▫ Buildings for life, ergonomics, disabled access etc. |
| Design for maintainable buildings / Ease of maintenance | Accounting for buildings that considered ongoing short and long term maintenance requirements. | ▫ This issue requires further investigation to define a measurable for LEnSE. |
| **3. Externalities** | | |
| Local employment opportunities/use of local services Specification/use of locally produced materials | Accounting for the buildings economic costs and benefits to the region and its contribution to ongoing economic sustainability. | ▫ Purchasing policies<br>▫ Materials/services purchased within site locality (km)<br>▫ Economic cost benefit analysis |
| Branding and external expression | Accounting for the contribution to corporate identity, organisational values and commitment to design excellence/technical innovation as part of a brand image. | ▫ This issue requires further investigation to define a measurable for LEnSE. |