DRAFT (31/08/2010) Deliverable not yet approved by the EC.

D1.2.1 Assessment of methodologies, normative, standards and guidelines for sustainability of buildings at national, European and International level.

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Issue Date	31 August 2010 (m06)
Deliverable Number	D1.2.1
WP Number	WP1: Awareness and methodology for sustainable building assessment baseline definition
Status	Working Document

Dissemination level	
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Summary

The D1.2.1 Assessment of methodologies, normative, standards and guidelines for sustainability of buildings at national, European and International level is a public document delivered in the context of WP1, Task 1.2: Analysis of existing methodologies, normative, standards and guidelines related to the sustainability of buildings with regard to develop the OPEN HOUSE methodology´s baseline.

This document is about the review of the current status of the development of international standards (e.g. TC59/SC 17, CEN/TC 350), global initiatives (e.g. SB Alliance, iiSBE) and international methodologies (e.g. LEED, DGNB) targeting the assessment of sustainable buildings.

Furthermore, information of all the different approaches of sustainable buildings will be collected, analysed and evaluated. Similiarities will be worked out and gaps identified. Based on the results the OPEN HOUSE methodology´s baseline can be defined.

Contents

Abbreviations

CEN	European Committee for Standardisation
GBC	Green Building Challenge
iiSBE	International Initiative for a Sustainable Built Environment
ISO	International Organization for Standardisation
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LEnSE	Label for Environmental, Social and Economic Buildings
OPEN HOUSE	Benchmarking and mainstreaming building sustainability in the EU based on transparency and openness (open source and availability) from model to implementation.
SB Alliance	Sustainable Building Alliance
SC	Subcommittee
SuPerBuildings	Sustainability and Performance assessment and Benchmarking of Buildings – SuPerBuildings (Project of FP7 from the EC)
TC	Technical Committee
UNEP-SBCI	United Nations Environment Programme - Sustainable Buildings and Climate Initiative

1. Introduction

In Task 1.2 of Workpackage 1 methodologies of normative, standards and guidelines for sustainability of buildings at national, European and International level have been collected and assessed.

The target group of the presented results are the partners of OPEN HOUSE and stakeholders for public participation.

All participants of the OPEN HOUSE project were involved to identify and analyse international assessment methodologies. Fraunhofer IBP provided the questionnaires and collected information about the status of international standardisation and international initiatives. Also in this section of the report, results from the SuPerBuildings project have been used.

This is the first deliverable of the project. The review of the current situation in sustainable building practices is essential for developing the methodolgy´s baseline and for the duplication of efforts.

This work is fundamental for the next steps in the project. Based on the results of this deliverable, the first preselection of indicators can be proposed in Deliverable D1.2.2.

2. Current Status of international standardisation and international initiatives / projects

The main objective of Task 1.2, also being the main objective of this deliverable, is the analysis and critical evaluation of existing assessment methodologies of building sustainability, respective standards and harmonisation activities, aiming at the identification of all indicators used in these systems.

As the OPEN HOUSE baseline and system are supposed to be closely linked to current harmonisation and standardisation activities, a special focus of the project lies on the analysis of these activities. Thus, the current developments elaborated by the ISO TC59 / SC 17 committee and the CEN TC 350 working group are closely regarded and taken into consideration in all aspects of the project. The OPEN HOUSE project is also closely linked to the SuPerBuildings project. This means that research and development activities as well as deliverables are exchanged between the projects to avoid duplication of work and to ensure an effective proceeding in both projects. In this context, findings from the SuPerBuildings Deliverable 2.1 [1] "Conclusions about the needs for development of sustainability indicators and assessment methods" are used as a basis for the deliverable at hand: One of the topics of SuPerBuildings Deliverable 2.1 is the "collecting of information (...) with regard to the availability of sustainability indicators" within a number of European and international harmonisation and standardisation activities. These harmonisation and standardisation activities closely analysed and described in the SuPerBuildings Deliverable are the documents drafted by the ISO TC59/SC 17 committee and the CEN TC 350 working group. Additionally, the work of the Sustainable Buildings Alliance (SB Alliance), the UNEP Sustainable Buildings and Climate Initiative (SBCI), the European research project LEnSE (Methodology Development towards a Label for Environmental, Social and Economic Buildings) and the European Coordination Action for Performance Indicators for Health, Comfort and Safety of the Indoor Environment (Perfection) are analysed. To avoid double work, these systems are not described again in this deliverable, but findings from this deliverable are used as a basis for the OPEN HOUSE objectives.

2.1 ISO TC59/SC 17

Combining the findings of the SuPerBuildings project and the research carried out in OPEN HOUSE Task 1.2, a development of the completeness of sustainability indicators can be found: In the documents released by ISO TC59/SC 17, up to now only environmental indicators are suggested (cp. SuPerBuildings D 2.1, chapter 3.3). For social and economic indicators, only recommendations regarding important topics

are made. So these social and the economic "pillars" of sustainability are not treated sufficiently yet.

2.2 CEN/TC 350

In the documents drafted by the CEN/TC 350 working group (cp. SP D 2.1, chapter 3.2), also environmental aspects and indicators are the ones most developed. Nevertheless, sets of important social and economic aspects are provided.

2.3 SB Alliance

Regarding the SB Alliance, the number of indicators suggested is reduced considerably (6 indicators are suggested), but environmental and social indicators are suggested equally (cp. SuPerBuildings D 2.1, chapter 3.4).

2.4 UNEP SBCI

The UNEP SBCI cannot be regarded as an initiative dealing with the sustainability of buildings in a holistic sense, as only climate relevant environmental aspects are accounted for (cp. SuPerBuildings D 2.1, chapter 3.5).

2.5 LEnSE

Within the LEnSE project, lists containing important sustainability issues in all "pillars" (environmental, social and economic) are compiled, potential indicators are identified and assessment methods are developed (cp. SP D 2.1, chapter 3.6).

2.6 Perfection

The Perfection project is only aiming at the development of performance indicators for the indoor environment. The categories regarded currently are named "Health and comfort", "Feeling of safety and positive stimulation" and "accessibility and functionality", so only the social aspect of sustainability is regarded here.

2.7 International Initiative for a Sustainable Built Environment (iiSBE)

About iiSBE

The International Initiative for a Sustainable Built Environment is not analysed in SuPerBuildings D 2.1 and is therefore described in more detailed here. It is an international non-profit organization with the main aim to lead the international

construction industry into the direction to sustainable building practices. Their focus is on research and policy with a special field of attention on information dissemination, building performance and its assessment.

They have an office in Ottawa and Maastricht and about 400 members from 20 countries. Local chapters exist in Czech republic, Israel, Italy, Poland, Portugal, Spain, Taiwan and Korea.

The Initiative launched the Green Building Challenge (GBC) process in 1996 to facilitate international comparisons in the assessment of the building performance. The GBC process led to conferences (SB conferences) with the subject on sustainable buildings.

Members are participating in working groups on the following topics:

Survey of rating tools

Urban Indicators

Zero Built Environments

Synergy Grids

Sustainable Infrastructure

One of their activities was the development of the GBC rating framework, which is now called SBTool.

SBTool

The SBTool is a rating framework or toolbox. Countries can use it as a basis to develop their own rating system. Therefore, they have to adapt it to their region and specific conditions like climate or environmental issues. The countries have to set the weights, context and performance benchmarks. It is modular in scope and local criteria can be easily inserted – ranging from 125 criteria to half a dozen. It deals with the four major phases: Pre-design, Design, Construction & Commissioning and Operation. It can handle new and existing buildings and up to three occupancy types.

Examples for assessment systems based on the SBTool are:

Protocollo ITACA, Italy

SBTool PT, Portugal

SBTool CZ, Czechoslovakia

SBTool VERDE, Spain

The method is structured in three levels: Issues – Categories – Criteria

In the Criteria the building can get scores according to the following scheme:

-1 = Deficient

0 = Minimum acceptable performance

+3 = Good Practice

+5 = Best Practice

The scores of the Criteria can be weighted on the dependence of their significance.

All in all there are 7 Issues, 28 Categories and 125 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 demand 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

Table 1. Structure of the SBTool [2]

Example for a Category with Criterias, here Category A, Site Selection, Project Planning and Development:

A	**Site Selection, Project Planning and Development**
A1	Site Selection
A1.1	Pre-development ecological value or sensitivity of land.
A1.2	Pre-development agricultural value of land.
A1.3	Vulnerability of land to flooding.
A1.4	Potential for development to contaminate nearby bodies of water.
A1.5	Pre-development contamination status of land.
A1.6	Proximity of site to public transportation.
A1.7	Distance between site and centres of employment or residential occupancies.
A1.8	Proximity to commercial and cultural facilities.
A1.9	Proximity to public recreation areas and facilities.
A2	Project Planning
A2.1	Feasibility of use of renewables.
A2.2	Use of Integrated Design Process.
A2.3	Potential environmental impact of development or re-development.
A2.4	Provision of surface water management system.
A2.5	Availability of potable water treatment system.
A2.6	Availability of a split grey / potable water system.
A2.7	Collection and recycling of solid wastes in the community or project.
A2.8	Composting and re-use of sludge in the community or project.
A2.9	Site orientation to maximize passive solar potential.
A3	Urban Design and Site Development
A3.1	Development density.
A3.2	Provision of mixed uses within the project.
A3.3	Encouragement of walking.
A3.4	Support for bicycle use.
A3.5	Policies governing use of private vehicles.
A3.6	Provision of project green space.
A3.7	Use of native plantings.
A3.8	Provision of trees with shading potential.
A3.9	Development or maintenance of wildlife corridors.

Table 2. SBTool, Category A with Criterias [3]

Example of Criteria with Benchmarks:

Benchmarks A for designated occupancies in Ottawa, Canada		Uses included	Apartment
			Retail
			Indoor parking
Renovation	Design Phase	Generic	.
A Site Selection, Project Planning and Development			●
A1 Site Selection		●	●
A1.1 Pre-development ecological value or sensitivity of land.			
Intent	*To encourage the selection of sites that have low ecological value or that are ecologically stable.*	Applicable phases (Active if green)	
Indicator	Ecological value and / or sensitivity of land used for construction, as determined by a competent authority or by existing documentation.	P-Dsn.	Dsn / Ops.
Information sources	Reference x, y and z.	□	□ / □
Applicable project type	Any occupancy except renovation projects		
Assessment method	Review of site analysis report by an ecologist.		
Applicable Standards	a		
	b		
	c		
	d		
Information Submittals	e		
	f		
Total project	Total project		Score
Negative	The site currently supports a wide range of flora and fauna.		-1
Acceptable practice	The site currently supports a range of flora and fauna consistent with other sites in the area.		0
Good Practice	The site currently supports a range of flora and fauna that is less diverse than other sites in the area.		3
Best Practice	The site currently supports a very limited range of flora and fauna.		5

Table 3. SBTool, Category A, Criteria A1 Site Selection [4]

2.8 Conclusions

In addition to the abovementioned standardisation and harmonisation activities, SuPerBuildings Deliverable 2.1 presents the results of an analysis of the following sustainability assessment systems:

BREEAM, DGNB, PromisE, HQE, Valideo, CASBEE, LEED, SBToolCZ, Klima:aktiv Gebäudestandard, TQB and GPR Gebouw.

In SuPerBuildings, as the focus lies on the identification of most used indicators respectively on the need to develop further common indicators, the evaluation of the systems includes a quantitative analysis on the use of indicators in the systems regarded.

In OPEN HOUSE, the focus lies on the exhaustive identification of indicators used in the different systems; so the count of the single indicators is not part of the system analysis. Following this, the interpretation of the SuPerBuildings D2.1 regarding OPEN HOUSE interests is the listing of all indicators identified and named in the SuPerBuildings Deliverable D 2.1.

Table 4. Indicators identified in SuPerBuildings D 2.1

Environmental indicators	***Economic indicators***	***Social indicators***
Primary energy consumption	Building adaptability	Indoor air quality
Water consumption	Ease of maintenance	Provision of safe and adequate bicycle lanes and facilities
Materials	Optimization of diverse and long-time local employment	Visual comfort
Waste production during use phase	Use and purchase of locally produced materials	Thermal comfort
Global warming potential	Increase of asset value of the site	Acoustic comfort
Ecological value of the site; landscape	Improvement of building user productivity	Access to public services and amenities
Ecological value of the site; degradation	Housing affordability and commercial viability	Access for users with physical impairments
Land use	Service life	Access to public transport
Ecological value of the site; evaluation of site ecology	Lifecycle costs	Vibrations
Ecological value of the site; ecological footprint	Flexibility / adaptility	Social and ethical responsibility

Depletion of Resources		Consideration of user`s needs
Photochemical Ozone Creation Potential		Individual lifestyles and preferences
Abiotic Depletion		Usability
Biotic Depletion		Protection from domestic accidents
Human Toxicity		Space efficiency
Eco-Toxicity		Building aesthetics and context
Use of wood		
Radioactive waste		
Needs for irrigation		

3. Analysis of international assessment methodologies

3.1 Identification of qualitative assessment methods

3.1.1 Questionnaire

In a first survey all participants were asked to identify qualitative assessment methods as described in the proposal for different European countries. The analysed countries were distributed among the partners in the following way:

Participant short name	*Country of origin*	*Country of qualitative assessment method*
All participants	all	International Level
All participants	all	European
Acciona. / VISESA / BGH	ES	Spain
		Portugal
		Malta
		Ireland
		Iceland
ACE	BE	Belgium
		The Netherlands
Apintech	GR	Greece
		Bulgaria
		Cyprus
Arup	UK	United Kingdom
Bouygues / EDF	FR	France
		Hungary
		Luxembourg
CCS / ZRMK	SL	Slovenia
		Bosnia
		Croatia
		FYROM
		Serbia
D´appolonia	IT	Italy

		Romania
		Turkey
DGNB / FGH-IBP	DE	Germany
		Austria
		Denmark
ETH	CH	Switzerland
		Estonia
Mostostal / ITB / City Wsraw	PL	Poland
		Chequia
		Slovakia
		Lithuania
		Letonia
SP	SE	Sweden
		Finland

Partners were asked to give information on:

- The Name of the qualitative assessment method
- The Organization
- The Source
- Diverse aspects

3.1.2 Results

The following qualitative assessment methods were identified:

International

SBTool (international)	International
BREEAM International	International
DGNB International	International
IPD Environment Code	International
Ecotech	Australia
Nabers	Australia
LEED Brazil	Brazil

AQUA	Brazil
BREEAM Brazil	Brazil
CALGreen	California
LEED Canada	Canada
Athena	Canada
Green Globes (Green Leaf)	Canada
3-Star	China
Gobas	China
DGNB China	China
CEPAS	China / Hong Kong
HK-BEAM	China / Hong Kong
TERI-Griha	India
LEED India	India
CASBEE	Japan
LEED Mexico	Mexico
SICES	Mexico
Green Star NZ	New Zealand
BCA GREEN MARK	Singapore
SBAT	South Africa
Green Star SA	South Africa
ABRI	Taiwan
LEED Emirates	United Arabian Emirates
BREEAM Gulfs	United Arabian Emirates
Estidama (Pearl Rating system)	United Arabian Emirates
LEED	USA
Energy Star	USA
Green Globes	USA
Green Builder Advisor	USA

Europe

LenSE
CEPHEUS
EU Green Building
BREEAM Europe
DGNB international

Austria

IBO-Ökopass

Total Quality
DGNB Austria

Belgium

BREEAM Belgium

Bosnia

no method identified

Bulgaria

DGNB Bulgaria

Croatia

no method identified

Cyprus

SBEM

Czech Republic

SBToolCZ

Denmark

Energy rating system

Estonia

no method identified

Finland

PromisE

Former Yugoslav Republic of Macedonia (FYROM)

no method identified

France

BREEAM France

Equer
ELODIE
ESCALE
H&E (Habitat et Environnement)
HQE (Haute Qualité Environnementale)
NF Logement – Démarche HQE

Germany

Bewertungssystem Nachhaltiges Bauen (BNB)
German Sustainable Building Certificate (DGNB)
GRE Certificate
Passive House Certificate
TÜV Süd ScoRE

Greece

GBTool (Greece)

Hungary

no method identified

Iceland

no method identified

Ireland

no method identified

Italy

Casa Clima - Klima Haus
LEED Italia
Protocollo Itaca

Netherlands

BREEAM Netherlands

Norway

ECOprofile

Malta

no method identified

Montenegro

no method identified

Latvia

IBNI - in preparation (based on BREEAM)

Lithuania

no method identified

Luxembourg

BREEAM Luxembourg
DGNB Luxembourg
HQE (Haute Qualité Environnementale) Luxembourg?

Poland

BREEAM-Poland
E-audit (polish SB-tool)
ITB-BEE

Portugal

Lider A
SB_Tool PT System

Romania

SMEU Urban Energy Management

Serbia

no method identified

Slovakia

no method identified

Slovenia

DGNB Slovenia
Eco Fund criteria for incentives for low energy and passive houses
ZKG – Quality label in building and civil engineering

Spain

BREEAM-ES
Guide for sustainable building of dwellings (Guía de edificación sostenible para la vivienda)
VERDE

Sweden

EcoEffect
Miljöklassad byggnad
Miljöstatus för byggnader (Environmental status for buildings)
Nordisk svanen (Nordic Eco-label)
P-märkt innemiljö och energi
Passivhus
Svanenmärkning

Switzerland

DGNB Switzerland
MINERGIE®
SBTool Switzerland (in process)

Turkey

BREEAM

United Kingdom

BREEAM
Code for Sustainable Buildings
Code for Sustainable Homes
SpeAR

In the next step the identified qualitative assessment methods from 3.1.2 were allocated to the partners, based on their language, country of origin and experience

with certain systems. Where information was accessible for the partners they were asked to give information on the systems within four questionnaires:

- Assessment and Certification Methods – Process and Structure
- Assessment and Certification Methods – Content and Indicators
- Life Cycle Assessment (LCA) and Life Cycle Costing (LCC)
- Energy Assessment

3.2 Assessment and Certification Methods - Process and Structure

3.2.1 Questionnaire

The objective of this questionnaire was to get an overview over the different processes and structures of the assessment methods. The participants were asked to give information on the following topics:

- Name of the qualitative assessment method
- Organization

  Legal Status of the Organization
  Year of Foundation of the Organization
  Internet Page
  Further Information to the Organization

- Information about the method

  Country of Origin
  Internationalization and Organization

- Information about the Versions

  Versions and Start of the Versions
  Pilotphase
  Further Information to the Versions

- Overview about the Certification Process

Assessment and Certification Process
Registration
Pre-Certificate (Planning Phase)
Certificate (after Commissioning)
Certification Body
Further Information to the Process

- Overview over the Structure

  Assessment
  Weighting
  Award/ Seal
  Further Information to the Structure

- Training of Assessors/ Auditors/ Professionals

  Pre-Qualification
  Types of Training
  Training Organisation
  Further Information to the Training

- Documentation

  Type of Documentation
  Further Information to the Documentation

- Divers
- Sources/ Literature

3.2.2 Results

For the following assessment systems information has been provided:

BREEAM ES
BREEAM Europe
DGNB
E-Audit
Eco Fund criteria for incentives for low energy and passive houses - Slovenia
Eco-Effect
Elodie
EQUER

Energy Efficiency Law - No. 5627
H&E (Habitat et Environnement)
HQE
Herramienta Verde
ITB-BEE
LEED
Miljöklassad Byggnad
Miljöstatus för byggnader
Minergie
Minergie Eco
Nf logement demarche HQE®
Nordic Eco-label (Svanen)
PromisE
Protocollo Itaca
SBTool PT
SMEU Software for Urban Energy Management
SPCR114E
Sustainable Building Guide for dwellings

This information will be forwarded to "Task 1.3 Definition of indicators, sustainabilty performance levels and procedures to evaluate them" and serve as a knowledge basis.

3.3 Assessment and Certification Methods - Content and Indicators

3.3.1 Questionnaire

To get an overview of the contents and indicators of the identified qualitative assessment methods of "2.1 Identification of qualitative assessment methods" the participants were asked to classify the indicators of the analysed system into a default structure. The structure was developed in accordance with the results of the analyse in "1. Current status of international standardisation and international initiatives / projects":

Primary Aspect	*Impact Category*	*Indicator*
Environmental	Ecological systems	Climate change
		Destruction of the stratospheric ozone layer

		Acidification of land and water resources
		Eutrophication of water bodies
		Photo-chemical ozone creation (POCP)
		Changes in biodiversity and other ecological systems
	Resources	Depletion of non-renewable primary energy
		Depletion of non-renewable resources other than primary energy
		Depletion of non-renewable freshwater resources
		Depletion of land resources with ecological or agricultural value
		Exhaustion of solid waste sites suitable for non-hazardous waste
	Waste	Pollution of water bodies by wastewater, other than eutrophication
		Hazards from disposal of non-radioactive hazardous waste
		Hazards from disposal or storage of radioactive waste
	divers	
Social	Health, society and culture	Ability of users with functional impairments to use the facility
		Personal safety and security of users

		Health, well-being and productivity for users of facility
		Health, security and well-being of off-site population
		Changes to social and cultural systems
	divers	
Economic	Economy	Financial risk or benefits for investors
		Housing affordability or commercial retail viability
		Changes in economic system (employment, economic stimulus)
	divers	
Technical		Fire protection
		Durability of the structure und robustness
		Clean and maintenance
		Resistance against hail, storm, high water and earthquake
	divers	
Functional		Area efficiency
		Conversion feasibility
	divers	
Process		Planning quality
		Construction quality

		Commissioning
		Operating quality
	divers	
Site		Micro-location
		Traffic connection
		Bicycle
		Neighbourhood
		Planning law
		Expansion
		Land consumption
		Site ecology
	divers	

For every indicator the following informations were asked for:

- Main category in the system
- Number in the system
- Indicator
- Sub-indicator
- Intent
- Short Description
- Unit
- Planning Instrument: Energy / LCA / LCC
- Double counting / similar indicators

- Qualitative indicator
- Quantitative indicator
- Based on: Standards / Guidelines / etc.
- Based on other Planning Instruments and Data Resources
- Building Lifecycle / stage: Product stage / Construction / Operation / End of Life
- Divers

3.3.2 Results

For the following assessment systems information has been provided:

BREEAM ES
BREEAM Europe
DGNB
E-Audit
Eco-Effect
Elodie
EQUER
HQE
Herramienta Verde
ITB-BEE
LEED
Miljöklassad Byggnad
Miljöstatus för byggnader
Nf logement demarche HQE®
Nordic Eco-label (Svanen)
PromisE
Protocollo Itaca
SBTool PT
SPCR114E
Sustainable Building Guide for dwellings

Mostly the indicators were classified in the right category by the participants. In order to get even results the indicators having been classified wrong were partly rearranged by Fraunhofer IBP. Further information on the indicators is given in the tables of D1.2.2.

Following the structure of the questionnaire which is based on suggestions made by CEN TC 350 and SB Alliance (cp. 3.3.1), results are summarized in the following chapter. The complete list of indicators reported by the partners can be found in Deliverable D1.2.2.

Environmental Indicators

Ecological Systems

Global Warming Potential (GWP) is a very common indicator issue: In the systems regarded, about 20 indicators aiming at the reduction of the Global Warming Potential could be identified. Comparing the units given for the indicators, it can be seen that roughly three different kinds of indicators exist: indicators measuring the GWP in kg or t CO_2-Equivalents, indicators measuring the percentage of carbon emissions reduction and indicators aiming at the assessment of different measures taken within the building (for example GWP reduction by the use of different refrigerants). Nevertheless, the aim of all these indicators is to show impacts on the Global Warming Potential of the Building.

Also for **Ozone Depletion Potential (ODP)**, which represents the depletion of ozone in the stratosphere, around 20 indicators were identified. Same as for Global Warming Potential, a certain amount of them is measured in kg CFC11-Equivalents; others give percentages of users of certain facilities. Some indicators that were just aiming at "emissions" or "emissions to air" without specifying them further, have been copied and inserted into all indicators related to emissions to air in the course of the reclassification of the indicators (cp. 3.3.1).

For **Acidification Potential (AP)**, 12 indicators were provided. Half of them use kg SO_2-Equivalents as a unit. The systems using this unit are mostly the same systems also measuring GWP and ODP in kg of equivalents (for example DGNB, ELODIE, EQUER, VERDE, Guía País Vasco, SBTOOL PL-E-Audit.

For **Eutrophication Potential (EP)**, six indicators were identified. Four of them use kg PO_4-Equivalents as a unit of measurement. The remaining two are mostly related to the Eutrophication that can be caused by soil erosion.

For **Photochemical Ozone Creation Potential (POCP)**, which represents the creation of near-ground ozone contributing to summer smog, about 10 indicators were reported, measuring the contribution to POCP in kg C_2H_4-Equivalents and percentage of users. Also two material related indicators were reported in this category.

The next category in the questionnaire was called "**Changes in biodiversity and other ecological systems**". All together, around 30 indicators were classified in this category. As this category title is rather unspecific, the indicators reported dealt with different themes such as risks from materials (7 indicators), use of certified wood (1 indicator), Microclimate and Heat-island-effects (7 indicators), biodiversity (9 indicators) and light pollution (3 indicators).

Resources

Depletion of non-renewable Primary Energy also is a very common indicator issue: 43 indicators dealing with this issue have been reported. Again, units of measurement are differing: Some indicators directly measure the Primary Energy Demand in kWh or MJ, some give percent of reduction or incorporation of energy. For others, no units of measurement are given, but comments explain that credits are given for different evidences of energy efficiency (e.g. BREEAM Europe). Also indicators handling the use of renewable energy sources are listed in this category.

Depletion of non-renewable resources other than primary energy is the next indicator category set in the questionnaire. About 30 indicators were provided. In general, three types of indicators were summed up in this category. The first one is directly called "Abiotic (Resource) Depletion Potential". It is using kg Sb-Equivalents as a unit of measurement and is based on the respective LCA indicator as developed by the Centre for Milieukunde Leiden. The second one is aiming at the recycling or reuse of materials and is often expressed as percentage of material reused or recycled. The third one aims at the enhancement of resource efficiency, for example promoting efficient management of construction site waste or the use of robust materials that have a low frequency of replacement. Nevertheless, essentially, all these indicators aim at the reduction of the depletion of non-renewable resource other than primary energy.

The next questionnaire category is called **"Depletion of non-renewable freshwater resources"**. Around 30 indicators were recorded for this category, all aiming at the reduction of freshwater consumption. Again, the units used show the different types of indicators existing: some of them measure the freshwater consumption in m^3 (e.g. DGNB, Guía País Vasco, BREEAM Europe), some require the percentage of water consumption reduced (e.g. Protocollo ITACA, LEED) and some don`t give units of measurement but credits if the existence of certain water saving devices is proven (e.g. BREEAM Europe).

"Depletion of land resources with ecological or agricultural value" is the next category in the questionnaire. Also around 30 indicators were reported. In general, all indicators listed here aim at the minimization of the depletion of land

resources with a high ecological or agricultural value. Anyhow, it can be seen that some of the indicators require an active improvement of the ecological site quality, whereas others more generally try to passively avoid the contamination of undisturbed areas or areas with high ecological and agricultural value.

The last resource-related indicator category is **"Exhaustion of solid waste sites suitable for non-hazardous waste"**. 13 indicators were reported, dealing with the amount of waste to disposal produced. Despite this fact, as the amount of waste produced itself is not an environmental impact category, the respective impact category to be defined is "Exhaustion of solid waste sites suitable for non-hazardous waste", which could be listed for both, resources and waste. The main units used within these indicators are tons of waste to disposal and percent of landfill waste weight that has been avoided by different practices. Some indicators don`t give a unit but state that credits are given for waste management facilities.

Waste

The first waste-related indicator category is called **"Pollution of water bodies by wastewater, other than eutrophication"**. In this category, 10 indicators were identified. They include water body pollution by sediments, heavy metals, chemicals, bacteria, surface-runoff and heat.

The next category is **"Hazards from disposal of non-radioactive hazardous waste"**. 5 Indicators are listed here. Indicators are measured in kg or tons of waste or account for the existence of respective facilities.

In the category of **"Hazards from disposal or storage of radioactive waste"** (4 indicators), mostly the weight of the respective waste is measured.

Divers

Nine Indicators remain in the category **"Divers".** All of them are aiming at a responsible material sourcing, meaning the use of local materials or materials with a low embodies environmental impact.

Social Indicators

Health, society and culture

For the first group **"Ability of users with functional impairments to use the facility"**, 3 indicators were found in the analysed systems. They are aiming to improve the accessibility for handicapped people.

For the next group **"Personal safety and security of users"** there are 3 indicators which describe techniques to avoid danger, accidents and catastrophes and provisions in the case of accidents and catastrophes.

For **"Health, well-being and productivity for users of facility"** the high number of 110 indicators were found. They are dealing with the topics Thermal Comfort, Indoor Air Quality, Microbial Contamination, Acoustic Performance, Visual Aspects, User Influences and other aspects.

In the category **"Health, security and well-being of off-site population"**, 7 indicators which describe the influence on the surroundings were found.

For **"Changes to social and cultural systems"** all in all 5 indicators were reported. They are discussing the aspects of the design.

Divers

In this class, 10 indicators were identified. The intent of them is to improve the accessibility by bike or alternative vehicles.

Economic Indicators

Economy

In this class, the first category is called **"Financial risk or benefits for investors"**. 6 indicators are listed here, all dealing with Life Cycle Costs of the building; units of measurement are Euro/area.

The next category is named **"Housing affordability or commercial retail viability"**. Only one indicator was reported here by VERDE. It is called Socio-economic impact and measures incentives for saling and renting in Euro.

For **"Changes in economic system (employment, economic stimulus)"**, one indicator was reported by SBTOOL PT, measuring the Cost value of the initial investment per m^2 of useful area.

Divers

In this class, only one indicator was listed called value stability (DGNB). It includes the assessment of different aspects such as proof of inspection of the area efficiency, modularity of the building, spacial structure of the building, electrical and media provision, heating, climate control (HVAC), water supply, and sewage disposal as contributors to value stability.

Technical

Only one indicator was identified for the category **"Fire protection"**.

For the class **"Durability of the structure und robustness"**, 7 indicators were reported. They are dealing with aspects of the durability of building components.

In the group **"Clean and maintenance"** 8 indicators are treating the ability and potential of cleaning and maintaining the structure.

For the group **"Resistance against hail, storm, high water and earthquake"** one indicator is evaluating the protection against impacts of the environment.

Divers

In this category, 17 indicators were identified. They are dealing with the quality of the buildings shell. For example in consideration of noise, moisture, heat transmission or air tightness.

Functional

For the group **"Area efficiency"**, 3 indicators were reported which are considering the economical handling of space.

For the class **"Conversion feasibility"** all in all 12 indicators were found. They are dealing with aspects how to adapt the building to other uses.

Divers

No diverse indicators were identified.

Process

For the group **"Planning quality"**, 10 indicators were identified. They contain issues of different aspects in the process of the planning. For example there is evaluated the preparation of the project, the integrated approach or the complexity and optimization of the design.

In the group **"Construction quality"**, 14 indicators are adressing aspects of the impacts of the construction site.

For the category **"Commissioning"** there were reported 8 indicators with the aim to optimize the performance of the building in the use stage.

In the category **"Operating quality"**, 13 indicators are considering aspects for an optimized use and operation.

Divers

No diverse indicators were identified.

Site

For the group **"Micro-location",** 6 indicators are considering the circumstances and risks of the buildings environment.

In the class **"Traffic connection Bicycle"**, 17 indicators are evaluating the provision of public transport, the availabilty of bicycle tracks or the safety for pedestrians.

For the group **"Neighbourhood"** there are 11 indicators which are assessing the conditions of the location or the availability of amenities.

In the group **"Planning law"** only one indicator was reported. It is measuring the building´s relation with its environment.

No indicators were identified for the groups **"Expansion"**, **"Land consumption"** and **"Site ecology"**.

Divers

In this class 2 indicators are evaluating aspects of the adjacent infrastructure.

Not yet identified

There were 10 indicators left which could not be yet integrated into the provided structure. These will be further examined in the later process.

Conclusion

Many indicators adressing aspects of sustainable buildings were identified and are a good basis for the development of the OPEN HOUSE method´s baseline. The results from this analysis will be used in D1.2.2 to give recommendations for the preselection of indicators.

3.4 Life Cycle Assessment (LCA) and Life Cycle Costing (LCC)

3.4.1 Questionnaire

The OPEN HOUSE system to be developed will be based on EU standards elaborated by the CEN/TC 350 working group. CEN/TC 350 standards for the sustainability assessment of buildings available so far are based on Life-Cycle-thinking and require Life Cycle Assessments (LCA) to be carried out in the course of a sustainability assessment. As the OPEN HOUSE system to be developed is supposed to be based on these standards, in the course of the analysis of building sustainability assessment methodologies throughout Europe, special questionnaires were created to be filled for the assessment systems already applying LCA and Life Cycle Costing (LCC). Objectives of these questionnaires were

- to identify the indicators used by LCA-based systems
- to collect information on different calculation methods existing for these indicators. This information will be used in Task 1.3 for the definition of the OPEN HOUSE indicators.
- to collect information and compare the general requirements and definitions of the LCAs such as system boundaries, functional units and data requirements. This information will be used in Task 1.5 for the OPEN HOUSE Baseline Definition.

The Questionnaire for LCA was based on the requirements set up by prEN 15978 "Sustainability of construction works – Assessment of environmental performance of buildings – Calculation methods" and was structured as follows:

- General Questions
- System Boundaries
- Data Requirements
- Building Quantifications
- Handling of time related assumptions / scenarios
- Indicators
- Evaluation of LCA results
- Reporting
- Verification

The questionnaire for Life Cycle Costing (LCC) was based on the requirements set up by prEN 15643-4 "Sustainability of construction works – Sustainability assessment of building – Part 4: Framework for the assessment of economic performance" and was structured as follows:

- General Questions
- System Boundaries, Indicators, Functional Unit
- Life Cycle Stages
- Information on costs included (in accordance with CEN/TC 350)
- Input data
- Calculation/ Quantification of results
- Evaluation of LCC results
- Documentation
- Verification

3.4.2 Results

Regarding the LCA questionnaire, for the following assessment systems information has been provided:

Basque Country – Guide for sustainable building for dwellings → no LCA
Breeam_ES
Breeam Europe
DGNB
E-Audit
Elodie
EQUER
Herramienta Verde

In almost all certification systems using LCAs, these are based on ISO 14040 and ISO 14044 (excl. *E-Audit*, that is based on EN 21931; for *Breeam _ES*, there was no respective information). The LCA in general is carried out quantitatively, meaning that results for different environmental impact categories have to be calculated and evaluated by transforming the results into "points" for the overall sustainable building assessment.

In most of the cases, the reference unit of consideration for LCA is the area per year, given in m² net surface area. Only in few systems (*DGNB, Elodie, E-Audit*) the principle of the "functional equivalence" according to suggestions made by CEN TC 350, meaning regarding building type, relevant technical and functional requirements, pattern of use and required service life are applied. Both, the reference study period and the required service life of the objective of assessment are differing between different systems (50-80 years), which complicates the comparison of respective results.

A complete inclusion of all life cycle stages suggested by CEN TC 350 can only be found with the *DGNB* and *Herramienta Verde* system, all other systems, according to the information given by the partners, neglect the construction process stage (for *Basque Country,* no information about the life cycle stages could be provided at all).

Data Requirements formulated are different, depending on the country of the assessment system. In most cases aggregated data and generic data is used. *Herramienta Verde* and *Basque Country* proclaim the use of average data combined for different manufacturers or production sites.

Within the building quantification, the net amounts for materials and building components are mostly specified identically (for *Breeam,* no specification was

provided), particularly based on drawings and on the as-built situation and corresponding to net units of products, materials, components and elements that constitute the building.

For a complete description of the object of assessment, in most assessment systems time related characteristics are treated by defining scenarios consisting of different assumptions. The scenarios are to be based on Real life data and normative data.

Climate conditions, which are representative of the location of the building and are used in the relevant scenarios, mostly considered according to the national regulations. Within the *Herramienta Verde* assessment, the Spanish adaption of the EPBD (Energy Performance of Buildings Directive) takes into account the different climate regions existing in Spain. Within the *DGNB* system, climate conditions are considered only by using information from the "German Regulation for Energy Saving in Buildings and Building Systems (EnEV)" which calculates the energy demand of the building with German average climate data.

In all LCA-based certification systems the following indicators are applied:

- Global Warming Potential,
- Destruction of the stratospheric ozone layer,
- Acidification potential of land and water resources,
- Eutrophication potential,
- Formation of the tropospheric ozone photochemical oxidants.

Abiotic Resource Depletion Potential for elements is only considered by *E-Audit* and *Herramienta Verde*. The only system which considers the Abiotic Resource Depletion Potential of fossil fuels is *E-Audit*. *Breeam* and *Herramienta Verde* are the only systems, which do not consider the input of renewable and non-renewable energy resources, primary energy. The input of secondary material is only considered by *Herramienta Verde*. *Elodie, Herramienta Verde, Breeam Europe* and *Basque Country* are regarding the input of renewable secondary fuels. The input of non-renewable secondary fuels is considered within *E-Audit, Herramienta Verde* and *Basque Country.* Hazardous waste to final disposal is only included in *Elodie, Herramienta Verde and Basque Country*. Non-hazardous waste to final disposal and radioactive waste to final disposal are neglected within the *DGNB* system. The input of net fresh water is considered by all systems, except *DGNB.* Components for re-use and materials for energy recovery are regarded by *Herramienta Verde* and *Basque Country*. Materials for recycling are considered by *Elodie, Herramienta Verde* and

Basque Country. Exported Energy is neglected within all systems. Partially no information could be provided for *E-Audit* and *Breeam*.

The elements of evaluating the results of the assessment are Rating, Weighting and Benchmarking (excl. the French systems, which have no rating nor weighting). The evaluation of the LCA results is different in each country, but in most cases a comparison with reference values is carried out.

Defined general aspects, assumptions and scenarios have to be reported in all systems (except *Breeam*, no information was provided here), but different regulations are made upon reporting of indicator results: In most cases, all indicators have to be reported for each module (excl. *Herramienta Verde*, where only indicators assigned to a specific module should be reported).

Only a few systems require a verification of the assessment results, e.g. *DGNB*, *E-Audit*, *Herramienta Verde* and *Breeam*. Within these systems, the consistency between the purpose of assessment and boundaries and scenarios used, and also the completeness of the quantification at the building level have to be verified.

For the LCC questionnaire, for the following assessment systems, information has been provided:

Basque Country → no LCC
Breeam_ES
Breeam Europe
DGNB
E-Audit
Eco-Effect
Herramienta Verde

For *Breeam_ES* and *Eco-Effect*, it is not mandatory to implement a LCC within the assessment. At European level The *DGNB* system and *E-Audit* are based on the prEN 15643-4 and on ISO 15685-5, *Herramienta Verde* only gives prEN 15643-4 as a basis and *Breeam Europe* is only based on ISO 15685-5. For *Breeam_ES* it was reported that no methodology or guidelines are provided concerning the LCC. *Eco-Effect* was developed before most of these standards, but there is no information provided on which standards it is based.

Within the abovementioned systems (Except *Breeam_ES* and *Breeam Europe*), the LCC is carried out quantitatively, meaning that the results of the cost assessment have to be calculated by transforming the results into "points" for the overall sustainable building assessment. The objective of the cost assessment is the

building, with its economic impacts and aspects, but without its site. Only costs related to the building are taken into account. In all systems the "lowest life cycle costs" over the building life cycle represent the most economic building. In terms of LCC, all systems are considering if the buildings have to be built, refurbished or renewed. Extending is considered by *DGNB* and *Herramienta Verde*. Retaining is only used within the *DGNB* system.

Building types, which can be assessed by all systems, are new built residential building and new built office and administration buildings. *E-Audit* is considering existing residential buildings and existing office and administration buildings. Within the *DGNB* system, a separate certification system exists, to assess these types of buildings, but also for new built and existing buildings with special use (e.g. laboratories). A new system for new built city districts is in evaluation stage. Within the *Eco-Effect*, all types of buildings can be assessed.

Indicators that are used for LCC in all systems are costs, given in [Euro]. Within the *DGNB* system, additionally, monetary values, meaning the incomes for building integrated electricity production by using renewable energy sources, are also used within the assessment.

In all systems, construction costs and user costs are calculated. The principle of functional equivalence (according to CEN TC 350) for consistent comparison of assessed buildings is considered within all systems. In all cases the type and use, area and/or volume, pattern of use, design life and reference study period, and the location of the building and climate conditions are considered within the assessment, within the *DGNB* system the location of the building is assessed separately.

The study period within *DGNB* and *Herramienta Verde* is 50 years and within the *E-Audit* assessment the study period can be chosen for 50, 60 or 80 years.

Eco-Effect includes cost information on taxes within its assessment of the use stage. In all cases cost information on repair and replacement of minor components / small areas and the replacement of major systems and components are considered. All systems, except *Eco-Effect*, are also regarding cyclical regulatory costs and cleaning. Energy costs and water related costs are considered within all systems.

Within the *Eco-Effect* system, no specific requirements are defined on the input data. The other systems use verified and average cost data. *DGNB* and *Herramienta Verde* use also product specific data.

In all cases, dynamic methods are used as calculation methods. *E-Audit* is also using a static method. For *Eco-Effect*, no information is provided on what kind of values

related to the indicator "costs" are calculated for the building. Within the other systems, costs of building construction, costs for technical appliances, costs for cleaning, supply and disposal costs and costs for operation, inspection and maintenance are calculated. *DGNB* and *E-Audit* consider also costs for refurbishment.

Eco_Effect does not provide any information on the evaluation of LCC results. In all other cases regarded, the elements of evaluating the results of the cost assessment are rating, weighting and benchmarking. *DGNB* and *Herramienta Verde* use also scoring, meaning that costs are connected to credit points.

In all systems, documentation is required, except *Eco-Effect*, where no information is provided regarding this point. Transparency, systematic order / structure and strict distinction between cost information included and results of assessment are required for the documentation within *DGNB* and *E-Audit*. Any relevant information that is missing within *DGNB* and *Herramienta Verde* has to be described.

Verification is required within *DGNB* and *E-Audit* assessment, in case the results are to be published. There is no information regarding verification provided for *Herramienta Verde*. In all other systems, consistency between the purpose of the assessment and boundaries used and completeness for the quantification at the building level have to be included in the verification.

3.4.3 Questionnaire

Energy assessment is an important part in the evaluation of sustainable buildings. Therefore an questionnaire has been provided to see how the energy assessment is integrated in the systems. It structured as follows:

- Name of qualitative assessment method
- Version and Buildung Type
- Which indicators of the Assessment Method are used for the Energy Rating?
- Is the Energy Rating based on the European Directive on the Energy Performance of Buildings (EPBD) (Directive 2002/91/EC EPBD)?
- Which kind of national legislation and normatives are used?
- On which energy indicators is the national standard based on?
- Further information

- Literature

3.4.4 Results

For the following assessment systems information has been provided:

BREEAM ES
BREEAM Europe
DGNB
E-Audit
Eco-Effect
Elodie
EQUER
HQE
Herramienta Verde
ITB-BEE
Miljöklassad Byggnad
Miljöstatus för byggnader
Minergie
Nordic Eco-label (Svanen)
Protocollo Itaca
SBTool PT
SPCR114E
Sustainable Building Guide for dwellings

This information will be forwarded to "Task 1.3 Definition of indicators, sustainabilty performance levels and procedures to evaluate them" and serve as a knowledge basis.

4. Conclusion

In Task 1.2 of Work Package 2, about 37 international and 64 European qualitiative assessment methods from over 50 countries were identified by the participants. Sometimes not all information asked by the questionnaire could be provided. Due to the different knowledge of the OPEN HOUSE partners it is possible that not all identified methods meet the definition of "qualitative assessment methods" in the Description of Work.

For all qualitative assessment methods, where information was accessible to the partners, a detailed description of the structure of the systems and their indicators

has been delivered. One of the main problems was the right categorization in the categories of the provided questionnaire. This was solved by a consistent rearrangement of them by the Task Leader Fraunhofer IBP. All in all a huge list of sustainability indicators emerged, which will be a good baseline for selecting the indicators and developing the structure of the OPEN HOUSE methodology.

The results will be used as the basis for Deliverable D1.2.2. First set of recommendations for standardisation for the baseline.

Acknowledgements

The OPEN HOUSE Consortium would like to acknowledge the financial support of the European Commission under the Seventh Framework Program

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