





#### ADAPTED SENIOR TRAINING PROGRAM ON BIM METHODOLOGIES FOR THE INTEGRATION OF EPD IN SUSTAINABLE CONSTRUCTION STRATEGIES 2020-1-ES01-KA204-083128

# Module 05

# Modelling of sustainable buildings (new construction and renovation) based on Life Cycle Assessment







Warsaw University of Technology





Module 05. Modelling of sustainable buildings (new construction and renovation) based on Life Cycle Assessment

Co-funded by the Erasmus+ Programme of the European Union

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5.1 Environmental certification of buildings

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5.2 Reference systems for environmental certification

5.3 Software for LCA calculation

5.4 BIM software for sustainable building modelling

Module 05. Modelling of sustainable buildings (new construction and renovation) based on Life Cycle Assessment

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- ENVIRONMENTAL CERTIFICATION OF BUILDINGS
- CONCEPT OF SUSTAINABLE BUILDING
- HISTORICAL DEVELOPMENT
- ASSESSMENT METHODOLOGIES, TOOLS AND SYSTEMS



# **ENVIRONMENTAL CERTIFICATION OF BUILDINGS**

The Environmental Certification of buildings is a voluntary certification, whose energy targets exceed those established in current regulations, which means that certified buildings have added value in terms of sustainability.

> Voluntary character.

- > Energy targets exceed those established in current regulations.
- Certified buildings added value (sustainability).



# **ENVIRONMENTAL CERTIFICATION OF BUILDINGS**

They guarantee a quality standard in terms of building performance, in aspects such as:

- ➢ Water consumption.
- Energy consumption.
- Comfort for its occupants.
- Use of environmentally friendly materials.



# **ENVIRONMENTAL CERTIFICATION OF BUILDINGS**

In short, they serve to measure the degree of sustainability of buildings.

- > By assessing three areas:
- ➢ Environmental.
- ≻ Economic.
- ➢ Social.





## SUSTAINABLE BUILDING CONCEPT

The process by which all actors involved (owners, planners, builders, construction teams, suppliers of materials, administration, etc.) integrate functional, economic, environmental and quality considerations to produce and renovate buildings in order to ensure that buildings remain:

- > Durable, functional, accessible, comfortable and healthy.
- Efficient in the use of resources (consumption of energy, materials, water, ...), favouring the use of renewable energies, using environmentally friendly materials (recyclable or reusable) and that do not contain hazardous products.
- > Respectful of their environment and neighbourhood, local culture and heritage.
- Economically competitive, especially when taking into consideration the long-life cycle associated with buildings, which involves aspects such as maintenance costs, durability and resale prices of buildings.





# SUSTAINABLE BUILDING CONCEPT



1. Actions focused on a single environmental impact

2. Systems for assessing the sustainability of buildings



# **HISTORICAL EVOLUTION**

#### **1.** Specific actions focusing on a single environmental impact

#### □ Bio-construction or eco-construction:

It focuses very specifically on the use of materials with low environmental impact, recycled and/or easy to recycle and easy to obtain and extract (i.e. with low embedded energy and minimal impact on the environment in their extraction). It also involves the use of building materials free of harmful chemicals and related to traditional construction.

#### **Passivhaus or bio-climatism:**

They seek an overall reduction in the energy needs of buildings, taking advantage mainly of the climatic conditions and the environment, through correct design, good geometry, the adaptation of orientations to use and the use of materials and construction systems that lead to this end.



# **HISTORICAL EVOLUTION**

#### **2.** Systems for assessing the environmental sustainability of buildings

Search for a joint environmental sustainability of the whole building:

LCA criterion: the best way to analyse environmental impacts is to perform a Life Cycle Assessment of the building (material extraction, design, construction, building use and end of life).

Buildings are too complex a product to be routinely subjected to an ordinary LCA, so most assessment systems, based on the different sub-systems of LCA studies, opt for:

Specific scoring: estimation of specific scores based on the inclusion of different criteria.



The different methodologies, tools and systems for assessing the environmental sustainability of projects identified in the market have been distinguished into the following three types:

- Sustainability assessment systems.
- Sustainable building standards.
- Assessment software.



- **1.** Systems for assessing the environmental sustainability of buildings
- Extensive knowledge in the sector
- They allow a gradation to be established in terms of compliance with a series of sustainability indicators.
- ➤ They can be certified by third parties, which comply with all the guarantees established by the system to accredit a certain level of sustainability.





#### 2. Sustainable building standards

- > They allow the identification of buildings that meet sustainability requirements.
- > They do NOT establish a gradation between them
- > They are minimum documents, of the compliant/non-compliant type.





#### 3. Evaluation software

Software developed to serve designers as a tool for sustainable design.

They are not certification oriented (contrary to previous evaluation systems).

Trends in this area have focused on two types:

- Environmental assessment software.
- > Energy performance assessment software.





#### 3. Evaluation software

Environmental assessment software:

Based on LCA, they place greater emphasis on the environmental impacts of the building.

Energy performance assessment software:

They allow the energy modelling of buildings; they can be used as a support to achieve an improvement in the evaluation carried out by any of the previous systems or standards. Module 05. Modelling of sustainable buildings (new construction and renovation) based on Life Cycle Assessment

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EUROPEAN SYSTEMS:
BREEAM
HQE
Ithaca Protocol
Green

SYSTEMS AT INTERNATIONAL
LEVEL:
LEED
SBTool
Casbee







#### BREEAM

ONE OF THE MOST WIDELY USED METHODS, AND THE FORERUNNER OF ENVIRONMENTAL CERTIFICATION SYSTEMS:

- BREEAM (Building Research Establishments Assessment Method), is a certification method, which trains specific assessors to be able to carry out the assessments, while certification is carried out by BRE Global.
- Managed by the BRE Trust (formerly the Foundation for the Built Environment), through its subsidiary companies BRE Global Limited and FBE Management Ltd.







#### BREEAM

**EXISTING VERSIONS:** 

✓ Offices

- ✓ Commercial establishments
- ✓ Education
- ✓ Prisons
- ✓ Courts
- $\checkmark$  Health centres and hospital uses
- ✓ Industrial units
- ✓ Collective residential
- ✓ Refurbishment of existing dwellings







#### BREEAM

SPECIAL VERSIONS:

- ✓ Code for Sustainable Housing for dwellings.
- ✓ Ecohomes new dwellings (Scotland) and renovations.
- ✓ Other buildings: to assess other typologies International for other countries.
- ✓ Communities planning and urban developments.
- $\checkmark$  In use version designed for building managers.
- ✓ Specific versions are available for Europe and Persian Gulf.







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#### BREEAM

DESCRIPTION OF THE SYSTEM:

- > Points or "credits" are awarded for meeting a number of requirements.
- > The scores are grouped into "sections" according to impacts.
- The total number of points scored in each section is multiplied by a weighting factor that takes into account the relative importance of each section, then added together to give an overall score.







#### BREEAM

SCORING SCALE:

- ✓ Pass (>30)
- ✓ Good (>45)
- ✓ Very Good (>55)
- ✓ Excellent (>70)
- ✓ Outstanding (>85)

#### **GRAPHIC REPRESENTATION: Star scale**







#### BREEAM

#### ASSESSMENT AND CERTIFICATION PROCESS:

A "Sustainability Panel" oversees the BRE guidelines, their publications, standards and certification systems in relation to environmentally sustainable building.

INFORMATION GATHERING	The design team / The building manager / The BREEAM assessor
CARRYING OUT THE EVALUATION	BREEAM-licensed assessors
THIRD PARTY VERIFICATION	BRE Global
CERTIFICATION	BRE Global
	HUDOS LINA 24





#### HQE

Certified is owned by AFNOR (French Association of standardisation and ISO representative) and certifies tertiary and residential buildings.

- French association HQE (Haute Qualité Environnementale High Environmental Quality) defines a whole series of standards for environmentally friendly buildings. The main one is the HQE procedure.
- This certification system is valid at national level and allows the certification of residential and non-residential buildings.







#### HQE

#### ENVIRONMENTAL ASPECTS (I):

The system identifies 14 environmental aspects or "sub-impacts" and covers two aspects: the environmental quality of the building and the environmental management of the project.

#### ECO-CONSTRUCTION:

Relationship between the building and the environment. Selection of building products, systems and processes. Construction site (low impact).

#### ECO MANAGEMENT:

Energy management

Water management

Management of waste generated by the activity.

activity.

Maintenance - conservation of environmental environmental performance.







#### HQE

#### ENVIRONMENTAL ASPECTS (II):

#### COMFORT

Hygrothermal comfort

Acoustic comfort

Visual comfort (lighting)

Olfactory comfort

#### HEALTH

Healthy room conditions Indoor air quality Sanitary water quality







#### HQE

**EXISTING VERSIONS:** 

- "NF Maison Individuelle-Démarch HQE<sup>®</sup>" For single-family dwellings.
- ➢ "NF Logement-Démarche HQE<sup>®</sup>" For collective dwellings or individual housing units.
- > "NF Bâtiments Tertiaires-Démarche HQE<sup>®</sup> For tertiary buildings:
  - ✓ Offices and Educational buildings.
  - ✓ Commercial (shopping centres and shopping areas) (\*).
  - ✓ Hotel (hotels and tourist residences, hostels) (\*).
  - ✓ Health (hospitals, university hospitals, clinics, polyclinics, medical dispensaries).
  - ✓ Logistics (building and logistics platform and
  - ✓ courier-type building) (\*).
  - ✓ Operation (existing tertiary buildings) (\*).







#### HQE

DESCRIPTION OF THE SYSTEM:

Based on the level of treatment defined for each impact, the referentials define the technical requirements.

The 14 sub-impacts of the project are hierarchised according to the particularities of the project into 3 possible levels of behaviour:

> "Basic" (equivalent to compliance with existing legislation or common practice).

➤ "Good".

➤ "Very good".







#### HQE

#### **ASSESSMENT PHASES:**

Assessment covers new and retrofit buildings and audits for certification are to be carried out in three stages:

- Programme/pre-project" phase.
- ➢ Building design" phase.
- > Construction/implementation" phase.







#### HQE

SCORING SCALE:

To achieve a minimum environmental profile, the following must be achieved:

> At least 3 levels with a "Very Good" rating.

> At least 4 levels rated "Good".

> And no more than 7 levels rated "Basic".







#### HQE

#### ASSESSMENT AND CERTIFICATION PROCESS:

3 audits are carried out prior to certification:

- During the "Programme" phase verification of the project's environmental objectives, dedicated budget, etc.
- During the "Building Design" phase verification of the environmental quality of the project.
- > During the "Works/Execution" phase verification of the realisation of the project.







#### HQE

#### ASSESSMENT AND CERTIFICATION PROCESS:

Certification companies are different, depending on the building typology and version that has been used to assess its sustainability.

INFORMATION GATHERING	The design team
CONDUCTING THE EVALUATION	Accredited professionals for the phases "Building Design" and "Construction/Execution".
THIRD PARTY VERIFICATION	Authorised consultants, on-site inspectors and professional diagnostics
CERTIFICATION	<ul> <li>It is carried out by AFNOR, through certifying buildings</li> <li>Tertiary buildings, CERTIVÉA, subsidiary of the B.</li> <li>Residential buildings, CERQUAL, a subsidiary of the B.</li> <li>Single-family dwellings, CÉQUAMI</li> </ul>







#### **ITACA Protocol**

ITACA (Istituto per l'Innovazione e Trasparenza degli Appalti e la compatibilita ambientale).

The Protocollo ITACA was developed by the working team consisting of regional and iiSBE Italy representatives. The system is based on the SBTool, adapted to Italy.





#### **ITACA Protocol**

#### ENVIRONMENTAL ASPECTS (I):

#### Energy and resource consumption:

- ✓ Primary energy in the life cycle.
- ✓ Renewable energies.
- ✓ Environmentally friendly construction.
- ✓ Drinking water.

Site quality:

- ✓ Level of soil contamination.
- ✓ Services.

Environmental achievements:

- ✓ Greenhouse gas emissions.
- ✓ Stormwater, grey and black water.





#### **ITACA** Protocol

#### ENVIRONMENTAL ASPECTS (II):

#### Indoor environment quality:

- ✓ Ventilation.
- ✓ Thermal comfort.
- ✓ Visual comfort.
- ✓ Acoustic comfort.
- ✓ Electromagnetic pollution.

#### Quality of services:

- ✓ Control of technical systems.
- ✓ Management and maintenance.
- ✓ Common areas.
- ✓ Domotics.






### **ITACA Protocol**

EXISTING VERSIONS:

> Existing Residential Buildings. Also applies to refurbishments.

## PHASES OF ASSESSMENT:

- The assessment can be carried out:
- > On completion of design.
- > On completion of construction.







### **ITACA** Protocol

DESCRIPTION OF THE SYSTEM:

A reference score is associated with each criterion (classified by subcategories). The score is set from -1 to 5 as follows:

- ✓ Negative -1.
- ✓ Sufficient 0.
- ✓ Good 3.
- ✓ Very good 5.

The final value of the evaluation is obtained by weighting the impacts according to their specific environmental weight.







### **ITACA** Protocol

DESCRIPTION OF THE SYSTEM:

It is rated according to a scale of:

- ✓ -1
- ✓ 0 (minimum acceptable level)
- **√** +1
- **√** +2
- **√** +3
- **√** +4
- **√** +5







#### **ITACA** Protocol

#### ASSESSMENT AND CERTIFICATION PROCESS:

ITACA oversees setting up the assessment system and provides the assessment tool (Excel).

INFORMATION GATHERING	The Italian regions oversee defining how the certification procedure will work and how accreditations for authorised assessors will be granted.
CONDUCTING THE EVALUATION	
THIRD PARTY VERIFICATION	ITACA supervises and controls the certification systems and guarantees the quality of the results issued.
CERTIFICATION	In some regions, iiSBE Italy has the status of a certifying body, protocollo





#### VERDE

The VERDE tool has been developed by the GBC Technical Committee with the collaboration of the ABIO-UPM Research Group, Institutions and companies associated to GBC Spain, and is based on the SBTool.

- VERDE recognises the reduction of the environmental impact of the building being assessed compared to a reference building.
- ➤ The reference building is always a standard building that strictly complies with the minimum requirements set by standards and common practice.
- The GREEN methodology is based on a life cycle analysis approach at each stage of the building process. It differs from the SBTool in that it considers the end-of-life, refurbishment or demolition phase.









### VERDE

#### ENVIRONMENTAL ASPECTS (I):

The criteria to be assessed are structured in six groups:

### 1. QUALITY OF THE SITE

- $\checkmark~$  Access to proximity services.
- ✓ Connectivity and transport.

## 2. QUALITY IN THE PROCESS

- ✓ Management protocols.
- $\checkmark\,$  Construction protocols.

## 3. ECONOMIC ASPECTS

- ✓ Life cycle cost.
- ✓ Value enhancement.









### VERDE

#### **EXISTING VERSIONS:**

### 4. ENVIRONMENTAL QUALITY

- $\checkmark\,$  Impact on the global and local environment.
- ✓ Resource consumption and waste generation.

### 5. TECHNICAL QUALITY

- ✓ Technical quality protocols.
- ✓ Mobility.
- ✓ Environmental quality.
- $\checkmark~$  Impact on the global and local environment.
- ✓ Resource consumption and waste generation.

### 6. SOCIO-CULTURAL AND FUNCTIONAL ASPECTS

- ✓ Health, comfort and user-friendliness.
- ✓ Functionality.









### VERDE

EXISTING VERSIONS:

It applies to newly constructed buildings, belonging to the following building typologies:

- $\checkmark\,$  Residential.
- ✓ Offices.
- ✓ Others (Commercial sector, hotels, educational centres, hospitals).









## VERDE

### ASSESSMENT PHASES:

Contemplates the following phases of the building life cycle:

- ➢ Pre-design.
- Design.
- ➤ Construction.
- ≻ Use.
- > End of life, rehabilitation or demolition.









### VERDE

DESCRIPTION OF THE SYSTEM (I):

A reference score is associated with each criterion.

These values are established based on the current applicable regulations and the analysis of the usual performance values of the building in the area.

The score is set from 0 to 5 as follows:

- ➢ 0 reference value corresponding to regulatory compliance, usual practice or average value.
- > 3 value defining the best practice rating.
- $\succ$  5 value that corresponds to the best possible practice at an acceptable cost.









### VERDE

DESCRIPTION OF THE SYSTEM (II):

- The final value of the assessment is obtained by weighting the reduced impacts in relation to the reference building.
- The weight assigned to each impact is related to the importance of that impact in the global situation in the case of global impacts and to the situation of the immediate environment in the case of local and regional impacts.





Module 5



# **EUROPEAN SYSTEMS**

#### VERDE

### SCORING SCALE:

The result is expressed as the reduction of impacts by the application of reduction measures and with the weight associated to each impact with a final score from 1 to 5 green leaves, with 0 leaves indicating bad environmental performance and 5 leaves indicating best possible practice.

¢C	n	BC niembro as	e cociado	ESPARA
	0	leaves	VERDE	Impacto Evitado 0 - 0,5
	1	leaves	/ERDE	Impacto Evitado 0,5 - 1,5
<b>N</b>	2	leaves	VERDE	Impacto Evitado 1,5 - 2,5
1	3	leaves	VERDE	Impacto Evilado 2,5 - 3,5
N.	4	leaves	VERDE	Impacto Evitado 3,5 - 4,5
	5	leaves	VERDE	Impacto Evitado 4,5 - 5,0



## VERDE

## EVALUATION AND CERTIFICATION PROCESS (I):

The assessment has the following steps:

- 1. Pre-registration of the building with GBC Spain.
- 2. VERDE assessment by an accredited assessor.
- 3. Application for certification.
- 4. Technical supervision of the application for certification and assessment carried out, communication of preliminary results to the applicant and deadline for submission of additional documentation for improvement.
- 5. Certification proposal and decision making.
- 6. Issuance of certificates.









### VERDE

EVALUATION AND CERTIFICATION PROCESS (II):

The evaluation is carried out at three levels:

- ➢ HV1 Evaluates the pre-design phase.
- ➢ HV2 Assesses the design and construction phases.
- HV3 Assesses the use phase of the building and can be used to obtain the green certificate.

In order to apply for environmental certification of a building, the applicant must accompany their documentation with an assessment carried out by an assessor accredited by GBC Spain, as well as successfully pass the Certification Process and proceed with the payment of the costs and usage fees according to the current rates.









### VERDE

EVALUATION AND CERTIFICATION PROCESS (III):

Established accreditation procedure:

- Education: Recognised intermediate or higher university degree related to construction and/or environmental management.
- Work experience: Work experience in development companies, construction companies or architectural or engineering technical offices equal to or greater than 18 months.
- ➢ Specific tests and/or exams for accreditation: Pass the specific exams for the accreditation of assessors carried out by GBC Spain.

Once compliance has been verified, the General Management of GBCe issues the corresponding EA Green accreditations.









#### VERDE

EVALUATION AND CERTIFICATION PROCESS (IV):

Maintenance of accreditation:

To maintain the status of accredited EA Green EA assessor, the completion of at least one full assessment of a building in the last 3 years must be demonstrated and attendance at the Technical Workshops for Assessors organised by GBCe must be justified.















## LEED

### LEED (Leadership in Energy and Environmental Design) System

It is a voluntary certification programme created by the United States Green Building Council (USGBC).

It is currently the most popular and widely used system in the world.

Objectives:

- > Define green building by establishing measurement standards
- Promote integrated design practices
- Stimulate green competitiveness
- Generate consumer awareness of green building benefits.
- benefits of green buildings.





## LEED

A system of **35 criteria** and prerequisites structured in **7 categories**:

- 1. Sustainable siting.
- 2. Water efficiency.
- 3. Energy and atmosphere.
- 4. Materials and resources (MRc).
- 5. Indoor environment quality.
- 6. Innovation and design process.
- 7. Regional priority.





## LEED

EXISTING VERSIONS:

- New Buildings and major refurbishments.
- Existing Buildings: Management and maintenance.
- > Commercial interiors.
- Buildings for internal use (Core & Shell).
- ➤ Schools.
- LEED Homes has also published a practical guide on how to carry out the assessment in the case of multiple buildings.



Source: <u>https://www.usgbc.org/articles/how-</u> match-leed-2009-rating-systems-leed-v4





## LEED

### FUTURE VERSIONS:

- ➤ Commercial.
- > Laboratories.
- Health and hospital centres.
- ➢ New urban developments.

#### **EVALUATION PHASES:**

- Design and construction.
- Management and maintenance.





### LEED

DESCRIPTION OF THE SYSTEM:

- Points are awarded for compliance with a number of requirements. Scores are grouped by "sections" according to the environmental impacts related to them.
- > A score of up to 100 points can be obtained per building.
- In addition to these 100 points, a further 10 credits can be added: four credits for specific regional environmental aspects and six credits for the implementation of design innovations. Thus, the maximum score per project can be up to 110 points.
- A project must comply with all pre-requisites and obtain a minimum number of points (40) in order to be certified.





## LEED

### SCORING SCALE:

- ✓ Certificate (>40 points).
- ✓ Silver (>50 points).
- ✓ Gold (>60 points).
- ✓ Platinum (>80 points).

Graphical representation:









### LEED

## EVALUATION AND CERTIFICATION PROCESS

Carried out by USGBC, according to the phases:

- 1. Registration with USGBC.
- 2. Application for Certification.
- 3. Review and certification.







### LEED

EVALUATION AND CERTIFICATION PROCESS

- **1.** Registration with USGBC.
- > Completed by the project manager through the LEED Online web application.
- Once the registration is completed, the USGBC provides access to the available online tools and all essential documentation for the certification process.







## LEED

### EVALUATION AND CERTIFICATION PROCESS

### 2. Application for Certification.

The LEED methodology allows the certification process to be carried out in a single final delivery of the construction phase or by separating it into two phases, as follows:

- Design phase: the criteria to be adopted in the project and the design considerations to be followed are established.
- Construction phase: The design is checked to ensure that what was established in the design is carried out in the construction phase.







### LEED

#### EVALUATION AND CERTIFICATION PROCESS

#### 3. Review and certification.

For each of the phases described above a score is awarded according to the credits awarded/denied, determines:

➤ LEED certification level achieved.





#### LEED

## EVALUATION AND CERTIFICATION PROCESS

INFORMATION GATHERING	The design team / The building manager / LEED Accredited Professional
CONDUCTING THE EVALUATION	USGBC
THIRD PARTY VERIFICATION	
CERTIFICATION	USGBC – via GBCI (Green Building Certification Institute)







#### iiSBE

International method developed by the teams of the Green Building Challenge (GBC) programme of the International Initiative for a Sustainable Built Environment (IISBE).

Sustainable Building Tool (SBTool): is the implementation of the tool known as GBTool. It is used to assess both buildings and projects, and also allows the development of certification systems adapted to local characteristics, which is its main feature.

The system allows to parameterise the weights of the different impact categories contemplated in the tool so that it adapts to the region in which it is going to be certified, use or schedules.







#### iiSBE

Its aim is to establish a reliable and comprehensive assessment and classification system for buildings.

- > To differentiate buildings according to environmental criteria.
- The aim is to provide methods for analysing the environmental performance of buildings.







#### iiSBE

ENVIRONMENTAL ASPECTS:

The tool covers a wide range of aspects in sustainable building, from which up to 120 different strategies can be chosen.

It does not only focus on the environmental parameter but also takes into account the economic and social aspects.

A) Site selection, design and project development.

B) Energy and resource consumption.

C) Environmental loads (aspects).

D) Indoor environmental quality.

E) Quality of service.

F) Social and economic aspects.

G) Cultural aspects.







### iiSBE

EXISTING VERSIONS:

- Residential (Isolated and en bloc).
- ≻ Hotel.
- > Office.
- Hospitals, day centres.
- Cinemas and theatres.
- Commercial, Food commercial, Supermarket, Shopping centres.
- ➢ Educational.
- > Laboratories.
- ➤ Small industry.
- > Outdoor parking, Outdoor area.





## iiSBE

**EVALUATION PHASES:** 

- ➢ Pre-design.
- Design.
- ➤ Construction.
- ≻ Use.

### DESCRIPTION OF THE SYSTEM

The GBTool is developed in an Excel format and consists of two modules:

- Module A: includes reference and weighting values, which have to be adapted to local conditions by the assessors.
- > Module B: assesses the sustainability of the building
- ➢ building.





### iiSBE

### ASSESSMENT AND CERTIFICATION PROCESS

As the assessment procedure is open and adaptable to local characteristics, with no priority for certification, iiSBE has not established guidelines for certification.

#### **RATING SCALE**

- -1 Negative practice.
- 0 acceptable practice.
- **3 Good Practice.**
- 5 Best possible practice.

Graphical representation:

The tool displays in spider web format the results for each of the 7 environmental aspects, rating them according to the scoring scale:



0 = Acceptable Practice; 3 = Good Practice; 5 = Best Practice





### CASBEE

Comprehensive Assessment System for Building Environmental Efficiency.

- It is a Comprehensive Assessment System for Building Environmental Efficiency, developed in Japan with the support of MLIT (Ministry of Land, Infrastructure, Transport and Tourism).
- CASBEE has fewer assessment criteria than other systems, so it may be easy to implement but less developed.
- The fact that it is easy to implement facilitates its first use and its regular introduction in the construction world. The intention is that, once it has found acceptance, its requirements will be increased.







### CASBEE

ENVIRONMENTAL ASPECTS:

Defined the BEE indicator as the quotient between the building performance quality (Q) and the environmental load (L), the impacts are classified according to them:

- $\triangleright$  Q building performance quality.
  - $\checkmark$  Q1 Indoor environmental quality.
  - $\checkmark$  Q2 Quality of service.
  - ✓ Q3 Surrounding environment.
- L environmental load.
  - ✓ L1 Energy.
  - $\checkmark$  L2 Resources and materials.
  - ✓ L3 Regional-global environment.




#### CASBEE

EXISTING VERSIONS:

- ➤ CASBEE-NC new construction.
- CASBEE-EB existing buildings (management).
- ➤ CASBEE-RN renovations.

There are versions adapted to specific purposes:

- CASBEE-NC short version assessment in 2 hours.
- CASBEE-TC for ephemeral architectures.
- CASBEE-HI assesses the heat island effect (urban areas).
- > CASBEE-UD groups of buildings and urban developments.
- ➤ CASBEE for Home for single-family houses.
- ➤ CASBEE-PD pre-design.





### CASBEE

EVALUATION PHASES

- ➤ Construction.
- Management and maintenance.
- ➢ Refurbishment.

It introduces a new indicator, called BEE (Building Environmental Efficacy), based on the concept of eco-efficiency: BEE = Q/L,



Each aspect and sub-aspect taken into account within each category (Q1, Q2, Q3, L1, L2, L3) is weighted according to its associated environmental impact.





### CASBEE

### SCORE SCALE

Scores are given according to the BEE value.

- ✓ Class C (low score)
- ✓ Class B-
- ✓ Class B+
- ✓ Class A
- ✓ Class S (excellent)



**CASBEE**<sup>®</sup>





#### CASBEE

#### EVALUATION AND CERTIFICATION PROCESS:

Once the application is submitted, it requires verification by a third party to ensure legality, in order to proceed to obtain certification and be published on the CASBEE website.

INFORMATION GATHERING	The design team / The building manager / Accredited professional
CONDUCTING THE EVALUATION	Design team in the case of less complex projects, in the case of complex projects, accredited rating agencies
THIRD PARTY VERIFICATION	Agencies for third party verification; other accredited professionals
CERTIFICATION	Japan Sustainable Building Consortium (JSBC)



Module 05. Modelling of sustainable buildings (new construction and renovation) based on Life Cycle Assessment









# **INTRODUCTION**

SimaPro Eco-it Air.e LCA OpenLCA GaBi TEAM **UMBERTO ONE CLICK LCA** REGIS eBalance EIME iPoint LifeCycle Tracker Aveny



# INTRODUCTION

- Nowadays, due to their great capacity to solve problems, these software tools facilitate the work of analysis when it comes to making calculations, using extensive and useful databases, following a strict methodology, etc.
- Below we will mention the most used or best valued ones, specifying what each one of them is used for, so that, if necessary, you can choose the one that best suits your needs.
- Some of these software have links with BIM software, or their results are readable in BIM formats. Likewise, the data they produce can be used to integrate into databases of the environmental impact of buildings.





# INTRODUCTION

- Nowadays, due to their great capacity to solve problems, these software tools facilitate the work of analysis when it comes to making calculations, using extensive and useful databases, following a strict methodology, etc.
- Below we will mention the most used or best valued ones, specifying what each one of them is used for, so that, if necessary, you can choose the one that best suits your needs.
- Some of these software have links with BIM software, or their results are readable in BIM formats. Likewise, the data they produce can be used to integrate into databases of the environmental impact of buildings

#### **EXPLANATORY NOTE**

The Ecoinvent database provides well-documented process data for thousands of products, helping to make accurate decisions on their environmental impact. It is based on more than 20 years of experience in developing LCA methodology and compiling LCI (Life Cycle Inventory) data for different industrial sectors.



# SimaPro

- > It specialises in the Life Cycle Analysis tool.
- It presents demos to get you started, support guides, as well as complete and varied databases.
- It is suitable for design or R&D departments, as it compares and analyses complex products by breaking them down into all their materials and processes.





# Eco-it

- Specialised tool for simplified life cycle analysis (LCA) and Carbon Footprint (CF) software for products.
- > Especially suitable for product and packaging designers.
- ➢ It is easy to use.





# Air.e LCA

- > Allows both LCA and Carbon Footprint to be included.
- > It can focus on both products and organisations.
- ➢ It is a powerful graphical interface for life cycle design and process mapping.
- > Allows verification reports and graphs to be generated automatically.
- ➢ It is integrated with Ecoinvent and Agri-footprint databases.





# **OpenLCA**

- > It is a free, open source, cross-platform software for complete life cycle analysis.
- A tool that has been developed since 2006, and as it is free you can modify the features to adapt it to your needs.
- > It is oriented to LCA but it is also possible to carry out carbon and water footprints.
- It has a wide range of databases.





# GaBi

- Sphera's Life Cycle Assessment Software (GaBi ts) is a tool for LCA and contains all the necessary elements for modelling products and systems.
- You can build models for any product, input and output balances for emissions, materials and energy and modify the parameters at any time.
- ➢ End-of-life scenarios are possible.
- Allows data export.





## TEAM

- > Very complete, flexible and powerful tool, but somewhat difficult to use.
- > It allows to enter information related to costs, flow chart, processes etc.
- Data entry is similar to GaBi.
- > It makes it possible to modify the parameters of the product life cycle at any time.
- ➤ It allows end-of-life analysis and export of information.





# **UMBERTO**

- Provides high quality data and transparent results.
- > Reflects the complete life cycle, inputs and outputs, flows between processes, etc.
- > It has high flexibility with respect to system boundaries.
- $\succ$  It also makes it possible to study the economic cost life cycle.
- > The information can be exported.





# **ONE CLICK LCA**

- ➤ It is used in more than 70 countries for application in low carbon projects and products.
- From building LCA, LCC and eco-design, through EPDs and product carbon footprinting, to GHG reporting.
- One Click LCA supports more than 40 green building certifications, integrates with almost all design tools and offers more than 90,000 data.







# REGIS

- Since its market launch in 1993, REGIS allows companies to analyse and monitor their Corporate EcoPerfomance.
- ➢ With the REGIS version including ecoinvent users can perform the LCA with special attention to the company's LCA with regionalised LCI/LCA.







## eBalance

- eBalance is a full-featured LCA software developed by IKE Environmental Technology with Chinese and global databases.
- > It is a professional tool for LCA studies of all kinds of products.
- > It is the best choice for LCA of products manufactured in China.





## EIME

> EIME v5 is an industry-oriented LCA software.

- Its simplicity and ergonomic interface allow all users to perform detailed analyses while reducing their complexity and resource requirements.
- ➢ It has eco-design functions for decision making.





# **iPoint**

- The iPoint Compliance Agent LCA module analyses the environmental performance of your products.
- It collects and combines relevant data from a wide network of suppliers and from the internal production of the software database, as well as data from the use phase and recycling and reuse targets. In this way, companies gain an overview of potential environmental risks and improvements.







## LifeCycle Tracker

➢ It is used to carry out carbon content assessments of companies' own products, as well as to carry out an eco-design or complete a full PAS2050 approved analysis.



#### For Site Managers

Use the tabs at the top of the page to view and enter data for your site(s). The Results Tab shows you the combined total emissions.

#### Version 2.1 - What's new in this version:

#### With the latest update:

- Flights can now be input using either, airport names or codes, total distance or fuel consumption.
- Mileage can now be input for scopes 1 and 3 based on vehicle ownership.
- · Cleaned up input and edit pages to work with one form.







## Aveny

Aveny LCA 2 is a complete LCA solution with an intuitive user interface and an elaborate workflow for minimal training requirements.



Module 05. Modelling of sustainable buildings (new construction and renovation) based on Life Cycle Assessment







- PROFESSIONAL BIM and LCA SOFTWARE
- COCON-BIM
- ONE CLICK LCA with BIM
- TALLY
- CYPE module IA-ACV
- CYPE and CSTB: ElodieBIM



# SOFTWARE PROFESIONALES BIM y ACV

BIM can become a real LCA lever because it facilitates access to data: project data and component data (whether finished products or raw materials).

However, to date, LCAs carried out based on numerical models are not yet so easy and systematic. First, the analysis is often simplified by the input data that come from the project.

These are mainly nomenclatures of quantities that are extracted from the model to be integrated into the LCA software with an environmental database - the LCA is then dissociated from the model.



## SOFTWARE PROFESIONALES BIM y ACV

Some software allows LCA to be carried out directly within the model, but the assumptions taken into account remain very limited and the databases are not connected.

Very often, only data linked to the surfaces and quantities of the main materials - concrete, steel, wood - are taken into account. Air conditioning systems and other materials are not considered.

Gradually this is changing and the performance of BIM software and its capabilities to calculate the Life Cycle Analysis of buildings is increasing.

Several outstanding examples are shown below.



# **COCON-BIM**

Cocon-BIM is a programme dedicated to the study of the environmental quality of materials and buildings and life cycle analysis (LCA) using the facilities offered by digital modelling (BIM). Completely rewritten, this software succeeds its predecessor Cocon Excel and makes it possible to take advantage of contemporary technological advances in digital modelling, thanks to the reading of BIM files (Ifc format) and 3D navigation.

Cocon-BIM complies with the European "Sustainability in Construction. Assessment of the environmental performance of buildings" (EN15643: "General framework" and EN 15978: "Calculation methods").





## **PROFESSIONAL BIM AND LCA SOFTWARE**



Source: <u>https://www.construction21.org/france/articles/h/DossierRE2020-realiser-des-ACV-de-batiments-a-partir-de-leur-maguette-numerique-BIM.html</u>



# **COCON-BIM**



#### FUNCTIONALITIES

- Compatible with Mac OS y Windows.
- Use any of the current Ifc formats (Ifc 2x3 and Ifc4) see our tips on modelling digital models here Use any of the current Ifc formats (Ifc 2x3 and Ifc4) - see our tips on modelling digital models here.
- Allows 3D visualisation/manipulation of buildings and their components.
- Allows to study the environmental impact of the construction or renovation of buildings.
- It draws on data from a variety of sources :
  - Francia:
    - FDES (Product Environmental Declaration Sheets) according to NF P01-010, DEP) mainly originating from the database <u>INIES</u>.
    - PEDs (Environmental Product Declarations) according to EN 15804.
    - PEP (Environmental Product Profiles according to EN 14040) mainly originating from the database <u>PEP EcoPasseport</u>.
  - Germany Environmental Product Declarations (EPD), including those of the database <u>OEKEBAU</u>.
  - Inglaterra Declaraciones ambientales de productos (EPD).
  - Swiss, including those in the Swiss database <u>Kbob</u> y <u>Ecolnvent</u>.



# **COCON-BIM**



### FUNCTIONALITIES

- It includes a database containing the description:
  - of more than 3,000 building materials, which contains information on:
    - thermal conductivity, specific heat, density,...):
      - thermal resistance or heat losses through walls.
      - inertia and thermal lag of composite walls (in accordance with EN 13786).
    - environmental through impact indicators (grey energy, GHG emissions, air and water pollution, resource depletion, water consumption, etc.).
  - of installations (lifts, boilers, heat pumps, lighting devices, plumbing, etc.) as well as environmental impacts due to:
    - its production.
    - its use.
    - Its end of life.
  - of construction machinery (for excavation, lifting, etc.) and means of transport (car, truck, train, ship, plane, helicopter, etc.) as well as the environmental impacts due to their use.



# ONE CLICK LCA with BIM

One Click LCA facilitates Life Cycle Assessments (LCA) for BREEAM and LEED certification. The solution proposed by Bionova Ltd. transforms BIM Models into Excel files with LCA reports. In addition to an easy-to-use interface and BIM format reading tool, One Click LCA provides plugins for several programs most common in the building design market.

Life Cycle Assessment quantifies the environmental impact of a building, both in terms of greenhouse gas emissions as well as materials and energy. It plays a central role in LEED v4, BREEAM and other green building projects.





# ONE CLICK LCA with BIM

Carrying out a life cycle assessment requires specialised knowledge. In contrast, ONE CLICK LCA allows non-specialised LCA users to calculate their calculation for a building in less than an hour using an automated process as well as the platform's web interface.

This plugin allows designers to find out the impact of their choices immediately and achieve the most sustainable results without having to carry out separate detailed studies for each option. In addition to BREEAM, ONE CLICK LCA supports LEED, DGNB, HQE, BNB, GREEN as well as many other certification systems and all common industry standards.





# **PROFESSIONAL BIM AND LCA SOFTWARE**



Source: <u>https://www.oneclicklca.com/one-click-lca-supports-bouygues-batiment-internationals-climate-strategy-to-cut-embodied-carbon-on-a-global-scale/</u>



# **ONE CLICK LCA with BIM**







# TALLY

KieranTimberlake's affiliate company, KT Innovations, partnered with Autodesk and thinkstep to create Tally.

Through a Revit plugin, Tally allows Revit users to integrate their BIM model with complete information about the building materials and architectural products that their structures will ultimately contain.

Tally quantifies the embodied environmental impacts of a building or materials used. It is currently approved for use with LEED v4.







# TALLY

Essentially, Tally adds another layer of detail to BIM by recognising materials that are not explicitly modelled, such as steel in concrete structures, and by taking into account the diverse range of material classes in a model.

In this way, Tally gives its users the ability to perform LCA of the entire building during design and to use the LCA data to perform comparative analyses of various design options showing their different environmental impacts.





#### 5.4 BIM software for sustainable building modelling







#### Results per Life Cycle Stage, itemized by Division



Source: <u>https://www.buildingenclosureonline.com/gdpr-</u> policy?url=https%3A%2F%2Fwww.buildingenclosureonline.com%2Fblogs%2F14-the-beblog%2Fpost%2F87127-leveraging-life-cycle-assessment-in-the-design-process




#### TALLY



SOURCE AND QUALITY OF DATA

Tally uses an LCA database that combines material attributes, assembly details and architectural specifications with environmental impact data resulting from the collaboration between KT Innovations and thinktep. LCA modelling is carried out in GaBi 8.5 using the GaBi 2018 databases and in accordance with GaBi databases and modelling principles.

The data used are intended to represent 2017 US values. Where representative data were not available, proxy data were used. For each entry, the datasets used, their geographic region and reference year are listed. Whenever possible, proxy datasets were chosen that are technologically consistent with the relevant entry.





#### TALLY



SOURCE AND QUALITY OF DATA

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#### EXPLANATORY NOTE

GaBi and SimaPro are the two most widely used software programmes for Life Cycle Assessment (LCA) and for calculating Carbon Footprints, Water Footprints, Water Footprints and Environmental Footprints, such as the European Union.





#### **CYPE module IA-ACV**

"Environmental Impact - Life Cycle Analysis" is a module of the Budget Generators and Archimedes. The Budget Generators are software tools that, with basic data supplied by the user and the optimisations that the user wishes to make through its graphic environment, automatically generate the budget and measurement of a building work (with chapter structure, breakdown of items and detailed measurement), obtaining the data from the CYPE Construction Price Generator. In addition to the budget and measurement, the Budget Generators provide, among others, the document where the Life Cycle Analysis of the building under consideration is defined, quantified and justified. The data imported into Archimedes can originate from a BIM model in IFC format.







#### **CYPE module IA-ACV**

To generate this document, the module "Environmental Impact - Life Cycle Analysis" obtains the information from the CYPE Construction Price Generator which is included in each building unit from PHASE A1 to A5 (more phases are currently in the process of being covered):

- The Global Warming Potential (GWP).
- Stratospheric Ozone Depletion Potential (ODP).
- Soil and water resource acidification potential (AP).
- Eutrophication Potential (EP).
- tropospheric ozone formation potential (POCP).
- > Abiotic resource depletion potential for non-fossil resources (ADPE).
- > Abiotic Resource Depletion Potential for Fossil Resources (ADFP).
- > The total primary renewable energy use (PERT).
- > Total non-renewable primary energy use (PERNRT).
- ➢ Net use of flowing water resources (FW).

















Proyecto: Situación: Promotor:

#### 8.8. Uso total de energía primaria renovable. - PERT (MJ)

			050	TOTAL DE	EENER	SIA PRIMARIA	RENOVABLE.	(MJ)		
		Capítu	los			A1-A2-A3 PRODUCTO	A4 TRANSPORTE	CONST	A5 RUCCIÓN	TOTAL
condicionamiento del terreno					33.552,93	0,0	)	0,00	33.552,9	
imentaciones					99.650,49	0,0	0	0,00	99.650,4	
tructuras						695.653,37	0,0	0	0,00	695.653,3
chadas y	particione	25				1.189.485,33	0,0	0	0,00	1.189.485,3
mates y a	ayudas					503.887,22	0,0	0	0,00	503.887,2
Istalaciones					122.844,74	0,0	0	0,00	122.844,7	
arpintería, cerrajería, vidrios y protecciones solares					630.304,83	0,0	0	0,00	630.304,8	
slamientos e impermeabilizaciones				56.161,00	0,0	0	0,00	56.161,0		
ubiertas					102.189,60	0,0	0	0,00	102.189,6	
evestimientos y trasdosados					1.503.016,21	0,0	0	0,00	1.503.016,2	
ňalización y equipamiento					89.989,66	0,0	0	0,00	89.989,6	
banización interior de la parcela					185.750,44	0,0	0	0,00	185.750,4	
guridad y salud				213.197,63	0,0	0	0,00	213.197,6		
tal						5.425.683,45	0,0	0	0,00	5.425.683,4
1.600.000 -								_	6	
1.600.000 -										
1.800.000 - 1.800.000 - 1.200.000 -										
1.000.000 - 1.000.000 - 1.200.000 - 1.000.000 -										
1.000.000 -/ 1.000.000 -/ 1.200.000 -/ 1.000.000 -/										
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1.000.000 1.000.000 1.000.000 400.000 200.000 0										

# cype



Source: <u>https://www.cype.pe/gestion/arquimedes/modulo-impacto-</u> ambiental-analisis-ciclo-vida/



#### **CYPE module IA-ACV**

The values of all these parameters are the result of the implementation of each work unit from the manufacturing (A1, A2 and A3) and construction (A4 and A5) stages, and are broken down by materials, packaging, machinery, auxiliary means and waste. This information can be consulted in the "Environmental impact indicators" tab of each work unit.

This detail and breakdown of the environmental indicators for each unit of work in the stages indicated allows a very precise analysis of the life cycle of a building work to be obtained. In the section Justification of the determination of the Life Cycle Analysis carried out by the programme, you can consult the validity of the data supplied by the Construction Price Generator.









# **CYPE Y CSTB: ElodieBIM**

This software allows to calculate the Life Cycle Analysis of a building in France. The software tool called ElodieBIM by CYPE meets the needs of French professionals who will be required to submit a technical report on the life cycle of buildings as of 1 January 2021 under the new RT2020 regulation.



#### Module 5





#### Module 5







# **CYPE Y CSTB: ElodieBIM**

The new RT2020 regulation, which replaces the previous RT2012, is more ambitious from the point of view of sustainability applied to the construction and housing sector, so it includes new sections related to the carbon footprint of buildings, while it is more demanding in terms of the criteria to be considered on thermal performance and energy consumption with the aim of encouraging the construction of nearzero consumption housing.

The ElodieBIM by CYPE software, which has been developed in collaboration with the French Scientific and Technical Centre for Building (CSTB), is able to calculate the impact of the phases of raw material extraction, transport to the factory, manufacture, product transport, product installation and construction thanks to the data provided by the French CSTB. In addition, the software is adapted to the Open BIM workflow.









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