BIM EPD

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

Module 01
Basic concepts and BIM (Building Information Modelling) technology applied to Life Cycle Analysis (LCA)

1.1 BIM methology

1.2 Introduction to LCA

1.3 BIM basics applied to LCA

Module 01. Basic concepts and BIM (Building Information Modelling) technology applied to Life Cycle Analysis (LCA)

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1.1. BIM methodology

METHODOLOGY

DIMENSIONS OF BIM

ADVANTAGES OF BIM METHODOLOGY
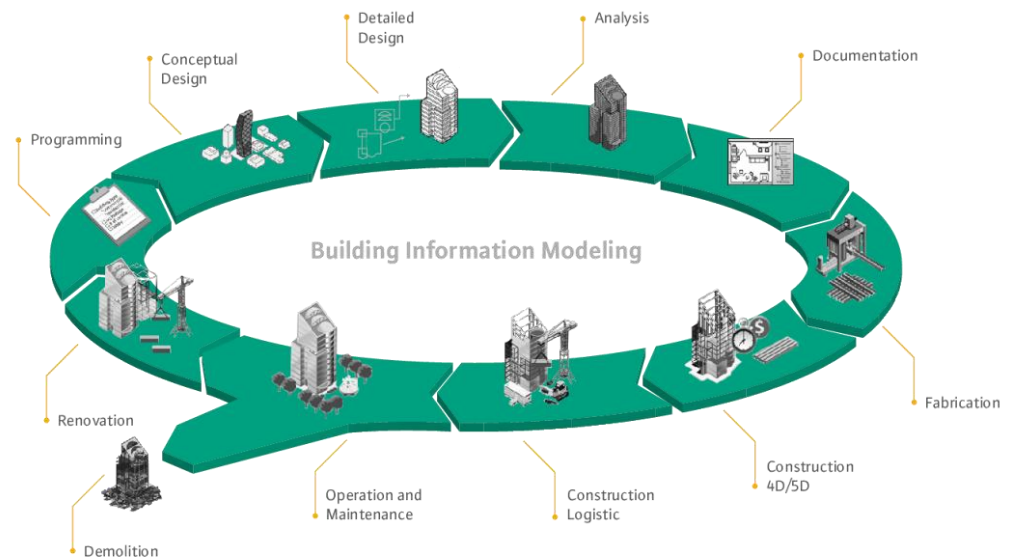
BIM IMPLEMENTATION

MOST COMMONLY USED BIM SOFTWARE

METHOLOGY

Building Information Modeling (BIM) is a collaborative working methodology for the creation and management of a construction project.

Its objective is to centralise all the project information in a digital information model created by all its agents:


Source: http://muhendzm.blogspot.com/2018/11/bimbuilding-information-modeling.html

Module 1   **1.1 BIM methodology**

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METHOLOGY

This new working method integrates all the agents involved in the building process: architects, engineers, builders, developers, facilities managers, etc., and establishes a communication flow between them, generating a virtual model that contains all the information related to the building throughout its life cycle, from its initial conception, during its construction and throughout its useful life, until its demolition.

Each agent involved in the building process is part of the BIM working method, each of them has their own competences and access to the relevant part of the information. That is why it **is essential that all of them know the BIM method and how its tools work.**
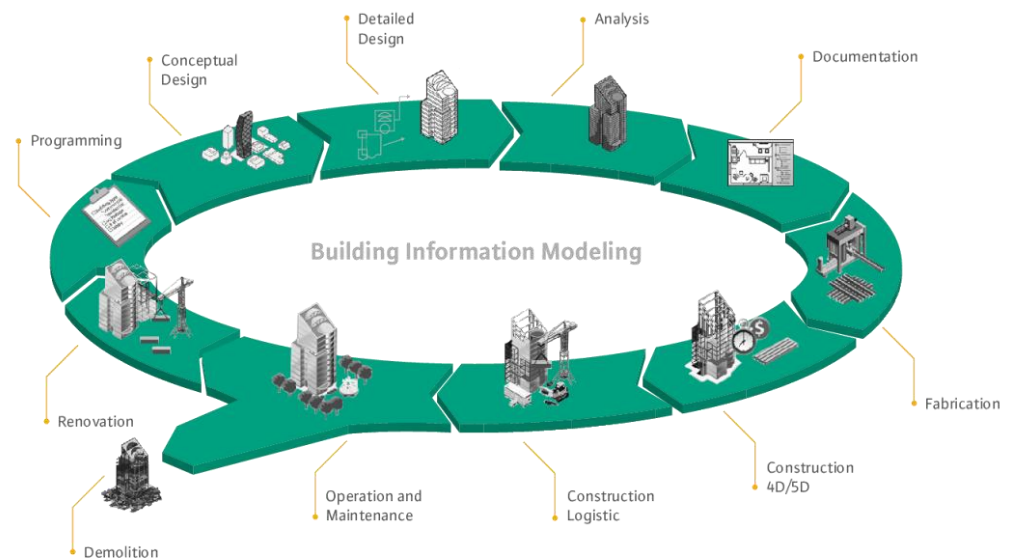
Source: http://muhendzm.blogspot.com/2018/11/bimbuilding-information-modeling.html

BIM DIMENSIONS

BIM is the evolution of traditional plan-based design systems, as it incorporates geometric (3D), time (4D), cost (5D), environmental (6D), maintenance (7D), health and safety (8D), etc.
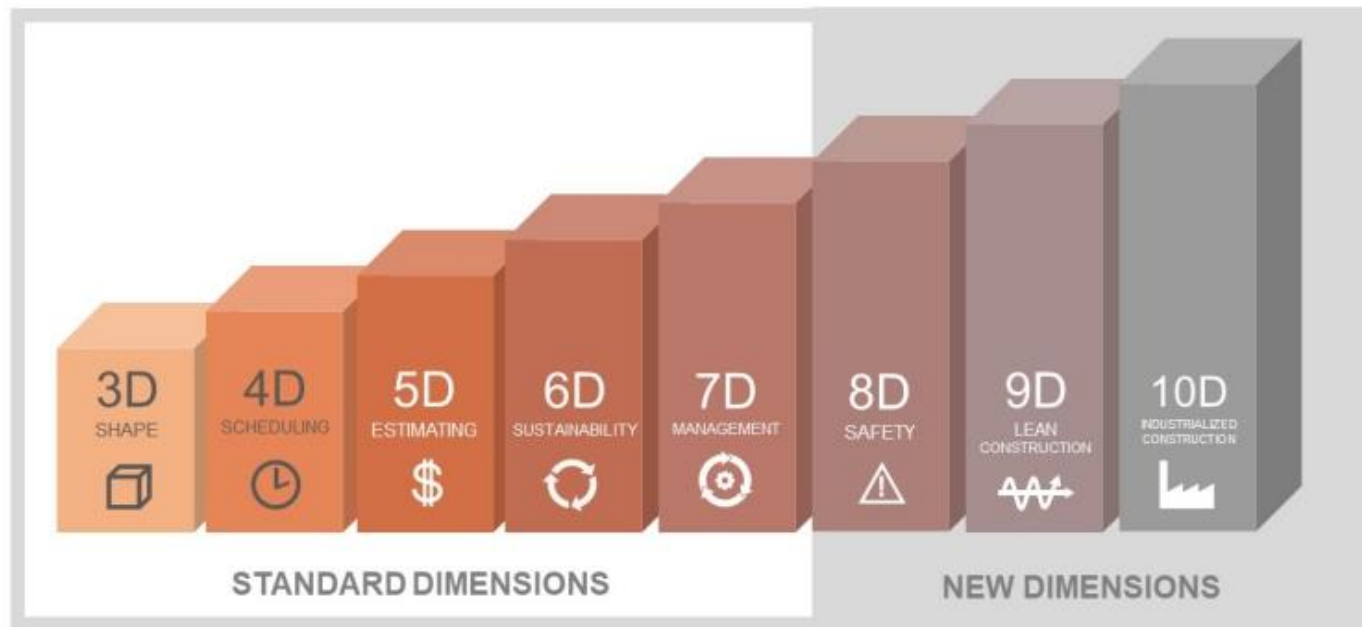

Source: https://biblus.accasoftware.com/en/what-is-10d-bim/

BIM DIMENSIONS

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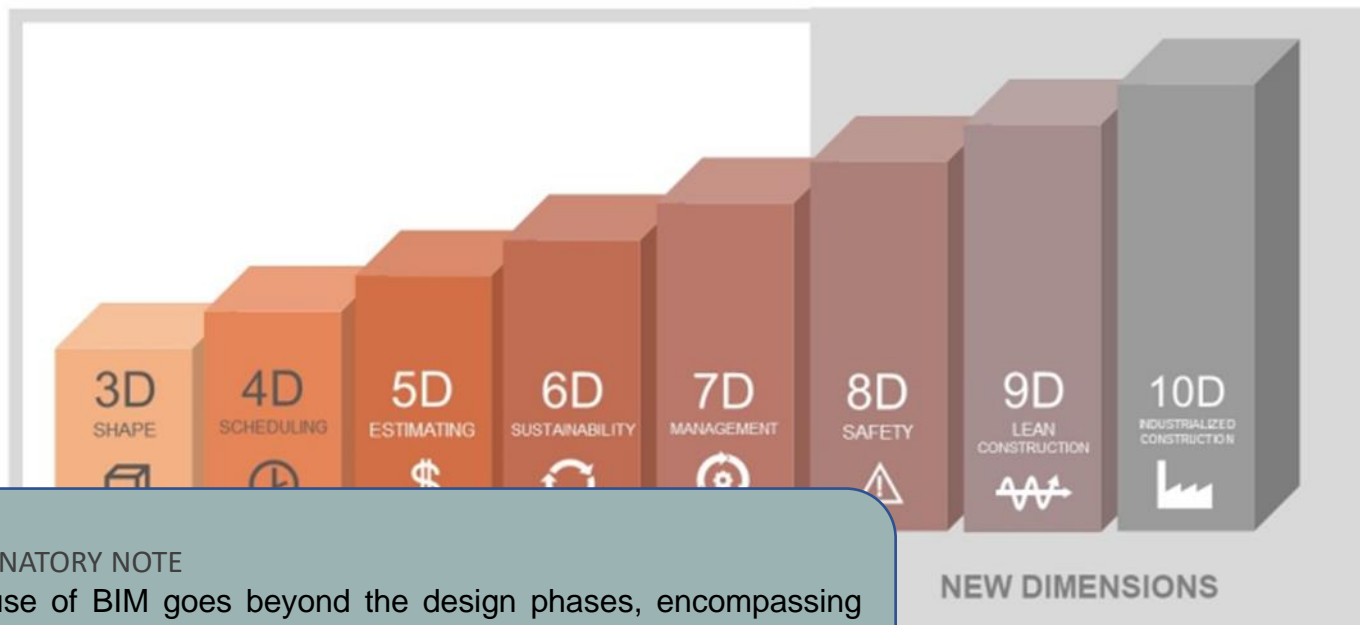

3D	4D	5D	6D	7D	8D	9D	10D
SHAPE	SCHEDULING	ESTIMATING	SUSTAINABILITY	MANAGEMENT	SAFETY	LEAN CONSTRUCTION	INDUSTRIALIZED CONSTRUCTION

NEW DIMENSIONS

EXPLANATORY NOTE
The use of BIM goes beyond the design phases, encompassing the execution of the project and extending throughout the life cycle of the building, enabling the management of the building and reducing the economic and environmental costs of operation.
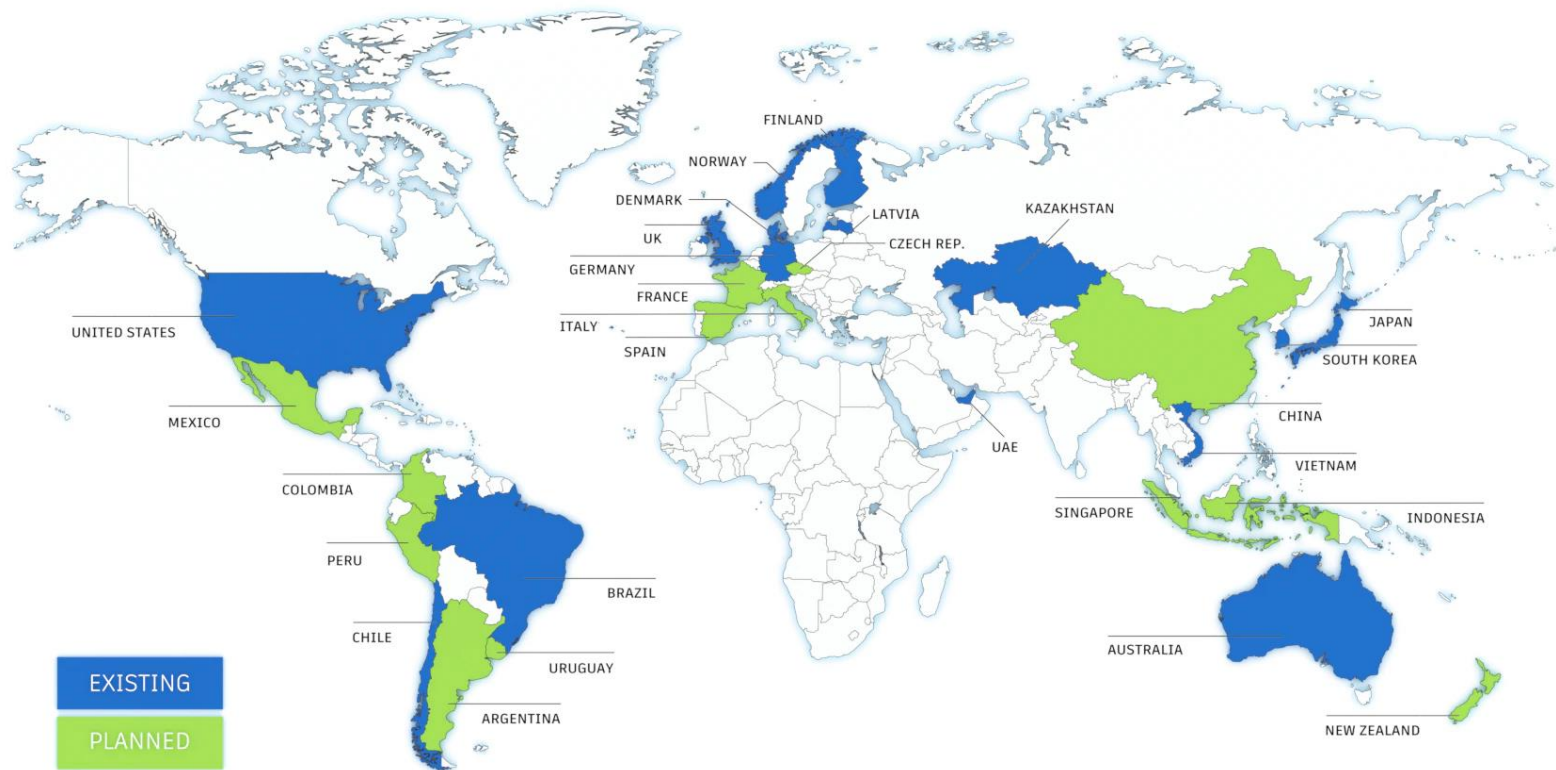
ADVANTAGES OF THE BIM METHODOLOGY

- **BIM platforms automatically update the information that is edited in any part of the model.** This means that if an element is modified in a floor plan, it is automatically modified in the sections, elevations and 3D views, just as if a feature is modified in a listing, it automatically changes throughout the project. **There is no possibility of human error. The information is always consistent.**

- As all the agents work on a single model, **there is no possibility of loss of information due to lack of coordination between versions** handled by different professionals.

- By establishing this method of working in parallel, all the agents can propose from the beginning the options they consider most convenient for the project, directly involving the whole organisation. **The project is developed in real time in a coordinated manner in a collaborative environment**, always under the supervision of the client.

- **BIM allows any required information to be available at all times**, both design and technical, costs, execution deadlines, maintenance, etc. It also allows modifications to be made in real time that will automatically update all these parameters, increasing the degree of personalisation and adaptation of the project to the client's needs.

- **Facility management tasks become much more efficient,** as all the real information on the asset is available on demand.

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BIM IMPLEMENTATION

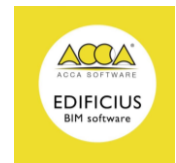Source: https://www.autodesk.com/industry/aec/bim/benefits-of-bim

MOST COMMONLY USED BIM SOFTWARE FOR 3D MODELING

BIM Modelling Examples

▶ **REVIT (Autodesk).** It allows the user to model with pre-designed parametric objects. Its use in BIM is well established and provides the necessary tools for the modelling of architectural design, engineering and construction of buildings.

▶ **ArchiCAD (Graphisoft).** Allows working with "smart objects" and virtual models complete with a database of construction information.

▶ **Allplan (Nemetschek).** The most widely used BIM software in Germany. With features similar to ArchiCAD and REVIT.

▶ **Aecosim (Bentley Systems).** It is mostly used in civil works and is oriented towards the execution phase of the building rather than the design phase.

▶ **Vectorworks (Nemetschek).** Programme focused on design for the construction industry, entertainment, landscaping and industrial mechanics.

▶ **Edificius (ACCA Software).** Less well known is a software that integrates BIM with real-time rendering to visualise the project while modelling.

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▶ **Allplan**
Germa

▶ **Aecos**
orient
design

▶ **Vecto**
constr
mecha

EXPLANATORY NOTE
BIM is the acronym for Building Information Modeling, although it could very well be Building Information Management, as BIM has a lot to do with information management and not just modelling. Many people still think of BIM as software, and we often hear people talk about BIM as if it were Revit, Archicad, or any other of the many platforms on the market. It is important to clarify that BIM is not software, although obviously software is part of BIM. BIM is a working method that is defined in the context of collaborative culture and integrated practice and is a profound transformation that affects all the design, construction and asset management processes we have known so far.

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▶ **REVIT (Autodesk).** It allows the user to model with pre-designed parametric objects. Its use in BIM is well established and provides the necessary tools for the modelling of architectural design, engineering and construction of buildings.

AUTODESK®
REVIT®

Source: https://unifilabs.com/BIM-software

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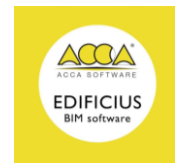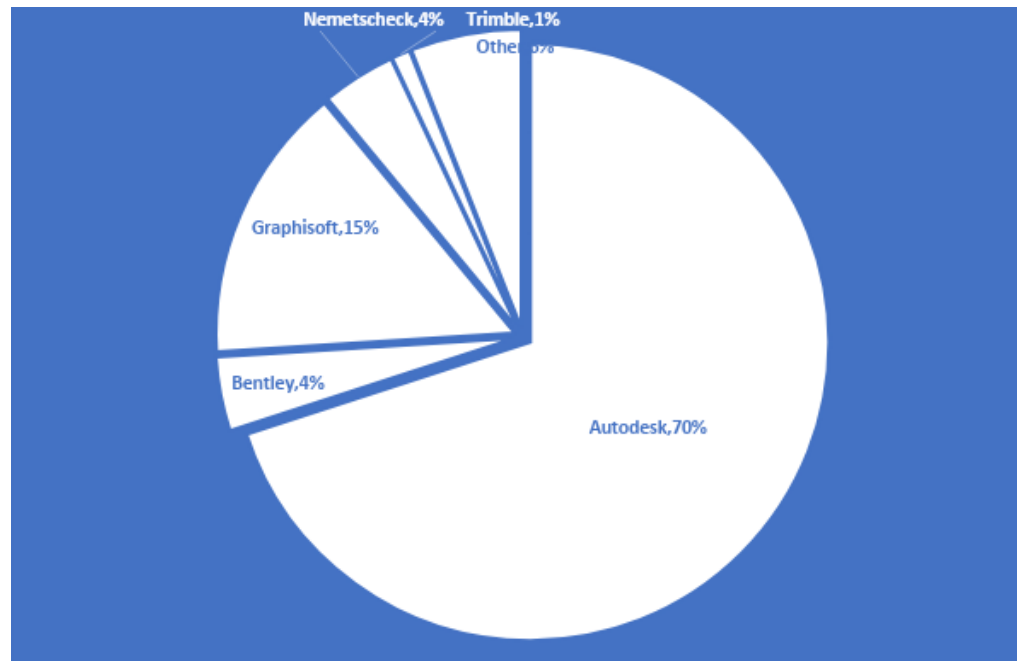
MOST COMMONLY USED BIM SOFTWARE FOR 3D MODELING

BIM Viewer Examples

▶ **BIM Collab Zoom.** It is a free BIM viewer compatible with different software, which has BCF workflows. To open any IFC and can help the user to find and visualise information faults, as it can filter and colour objects.

▶ **BIMx (Graphisoft).** Available in both mobile and desktop versions. With Hyper-Model technology, it offers smooth 2D and 3D navigation within the project. Full compatibility with ArchiCAD.

▶ **Solibri Model Viewer.** Allows to open and view all IFC files and also files edited with Solibri Model Checker.

▶ **A360 (Autodesk).** It is an online viewer that can be accessed from any device. Compatibility with a multitude of CAD formats and visualisation of BIM designs without the need to install any software.

▶ **DALUX BIM Viewer.** The free version of this app can handle large and complex BIM models. Offline accessibility and support for formats such as IFC, RVT, PDF, DWG, DWFx, PNG and JPEG.

▶ **BIMSYNC.** It is also a high-performance 3D viewer with automatically generated 2D floor plans for a complete overview of all BIM model.

▶ **BIM Vision.** BIM Vision is a free IFC model viewer. It allows you to view virtual models from CAD systems such as ArchiCAD, Revit, VectorWorks, Allplan and others without the need for a commercial licence for these systems or to have a viewer for each particular system, as well as IFC 2×3, 2×4, 2×3, 2×4 and 2×4 formats.

▶ **BIMkeeper.** Fully online building management system with advanced 3D IFC viewer. Stores all BIM model information. Very useful for organising a development, maintenance and support process.

▶ **usBIM Viewer (ACCA Software).** usBIM.Viewer is also a free IFC model viewer that allows you to import and export files in standard IFC format from Open BIM models made with any BIM Authoring software (Revit, Edificius, ArchiCAD, Sketchup, Rhino, Tekla, etc) or Tool.

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MOST COMMONLY USED BIM SOFTWARE FOR 3D MODELING

BIM Viewer Exa

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EXPLANATORY NOTE

IFC: open file formats can be read and modified by anyone. To respond to these needs, the IFC (Industry Foundation Classes) format was created, a file format that allows the exchange of an information model, without loss or distortion of data and information, and is one of the most widely used standards.

wer+
BIM viewer and more

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Examples of Site Planning or 4D

▶ **Naviswork (Autodesk).** Allows users to open and combine 3D models, navigate them in real time and review the model using a set of tools including commenting, redlining, point of view, and measurements. A wide range of add-ons for interference detection, and 4D time simulation.

▶ **SYNCHRO.** Provides solutions to accurately visualise, analyse, edit and track an entire project, including logistics and temporary works. Visual environment that engages all team members in a transparent process to optimise construction projects. Well established in the market.

▶ **TCQi.** It is a software for virtual construction, Software-as-a-Service (SaaS) of the construction process, based on the TCQ methodology and the contributions of its users, which includes 12 modules for the Collaborative and Integral Management of Projects and Works during their entire life cycle.

▶ **Project (Microsoft).** Project management and BIM-applicable software developed and sold by Microsoft. It is designed to help a project manager develop a schedule, allocate resources to tasks, track progress, manage budget and analyse workloads. It can be linked to other software.

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Examples of Measurement and Budgeting or 5D

▶ **Arquímedes (CYPE).** It is linked to REVIT and is a very complete programme for 5D BIM. It gives the option to carry out measurements, budgets, certifications, specifications, as well as the manual of use and maintenance of a building.

▶ **Presto - Cost It.** You can generate the complete measurements of the model, in a structured and traceable way, convert the measurements into the budget needed to value or tender the project and obtain all related information, such as usable and built-up areas, relevant parameters for pricing or documentation.

▶ **Gest.MidePlan (Arktec).** It performs the automatic measurement of projects, based on the BIM model in IFC format. MidePlan's project budget calculation allows you to automatically obtain a complete valuation of all the elements designed. As the budget is obtained from the project design, its values are real measurements.

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Examples of Environmental Management and Energy Efficiency or 6D

▶ **EcoDesigner (Graphisoft).** It allows the user to assess the energy performance of the building with compliant technology, supported by multiple thermal blocks. As a result, designers can make energy calculations dynamically and accurately from the beginning, during and until the end of the project.

▶ **Green Building Studio (Autodesk).** Flexible cloud-based service that allows you to run building performance simulations to optimise energy efficiency early in the design process. It has tools to design high-performance buildings in a fraction of the time and at a lower cost than conventional methods.

▶ **CYPETHERM HE.** It can also be used to calculate the thermal load of buildings according to the Radiant Time Series Method (RTSM), with full integration into a BIM workflow.

▶ **RIUSKA.** An efficient and versatile energy and comfort simulation application. Ideal in cases where detailed heating and cooling load calculations or complete energy consumption calculations are required.
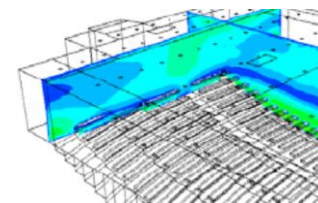
MOST COMMONLY USED BIM SOFTWARE FOR 3D MODELING

Examples of Environmental Management and Energy Efficiency or 6D

▶ **EcoDesigner (Graphisoft).** It allows the user to assess the energy performance of the building with compliant technology, supported by mu[...]

ca[...]

u[...]

> **EXPLANATORY NOTE**
> Currently, the vast majority of energy efficiency calculation software is fully developed and closely linked to the regulations of each country.
> However, within the 6D Dimension in the BIM field, the environmental aspects focused on the efficiency of natural resources and the calculation of life cycle impact analysis indicators are not so widespread, with some software and methodologies still at a very embryonic stage and without a stable, fully developed and mandatory regulation on which to establish common calculation foundations for all countries. Precisely, the main focus of this course will cover the latest developments in this field

▶ **G[...]** yo[...] ea[...] b[...] m[...]

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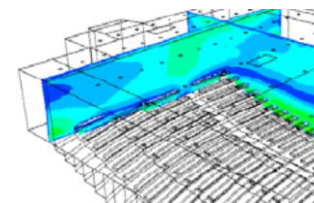
MOST COMMONLY USED BIM SOFTWARE FOR 3D MODELING

Examples of Facility Management or 7D

▶ **Maximo (IBM).** IBM Maximo from its Building Information Models module, allows integration with BIM projects and gives the option of having a single updated model where all stakeholders can look at and connect for the maintenance phase of their assets.

▶ **ARCHIBUS.** Management software designed to automate the flow of information from the design and construction phases of the property through to full asset lifecycle management. It is one of the most widely used.

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MOST COMMONLY USED BIM SOFTWARE FOR 3D MODELING

Examples of Facilities Design

▶ **CYPECAD MEP.** It is a programme for the design and dimensioning of the building envelope, distribution and installations on a BIM model. Depending on the country selected in the creation of a building, CYPECAD MEP performs different checks and dimensioning.

▶ **DDS CAD.** In terms of functionality, DDS offers solutions for electrical, plumbing, heating, ventilation, air conditioning and photovoltaic systems. It is compatible with the Open BIM design process.

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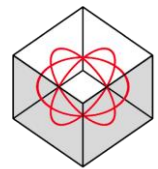
MOST COMMONLY USED BIM SOFTWARE FOR 3D MODELING

Examples of structural Design

▶ **Tricalc.** Software that calculates steel, concrete and any other material structures with the same way of working as the original software and with all its features.

▶ **Tekla Structures.** It is an integrated, model-based 3D solution for managing multi-material databases (steel, concrete, timber, etc.). Features interactive modelling, structural analysis and design, and automatic drawing creation.

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1.2. Introduction to LCA

DEFINITION

SCOPE OF LCA

OBJECTIVES

FIELDS OF APPLICATION OF LCA

LCA STAGES

LCA CALCULATION PHASES

ISO 14040 DEFINITIONS

ECO-LABELLING

ENVIRONMENTAL PRODUCT DECLARATIONS (EPDS)

LCA APPLIED TO THE BUILDING

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DEFINITION

Life cycle: Consists of the set of stages of a product from the extraction and processing of raw materials, production, transport, marketing, use and maintenance, to the final management when it reaches the end of its useful life.

The sum of all inputs of matter and energy (inputs) and outputs of waste and emissions (outputs) constitutes the environmental impact of the product.

| RESOURCE EXTRACTION | MANUFACTURING | PACKAGING AND TRANSPORT | USE | END OF LIFE |

DEFINITION

SETAC (1993): "LCA is an objective procedure for assessing the energy and environmental loads of a process or activity by identifying the materials and energy used and discharges to the environment. The assessment is carried out over the entire life cycle of the process or activity, including extraction and treatment of raw materials, manufacture, transport, distribution, use, recycling, reuse and disposal".

Society of Environmental Toxicology and Chemistry

ISO (1997): "LCA is a technique for determining the environmental aspects and potential impacts associated with a product by: compiling an inventory of the relevant inputs and outputs of the system; assessing the potential environmental impacts associated with those inputs and outputs; and interpreting the results of the inventory and impact phases in relation to the objectives of the study".

ISO 14040:1997

SCOPE OF LCA

What do you consider a LCA?

INPUTS

Raw materials

Energy

OUTPUTS

Co-products   Emissions   Waste

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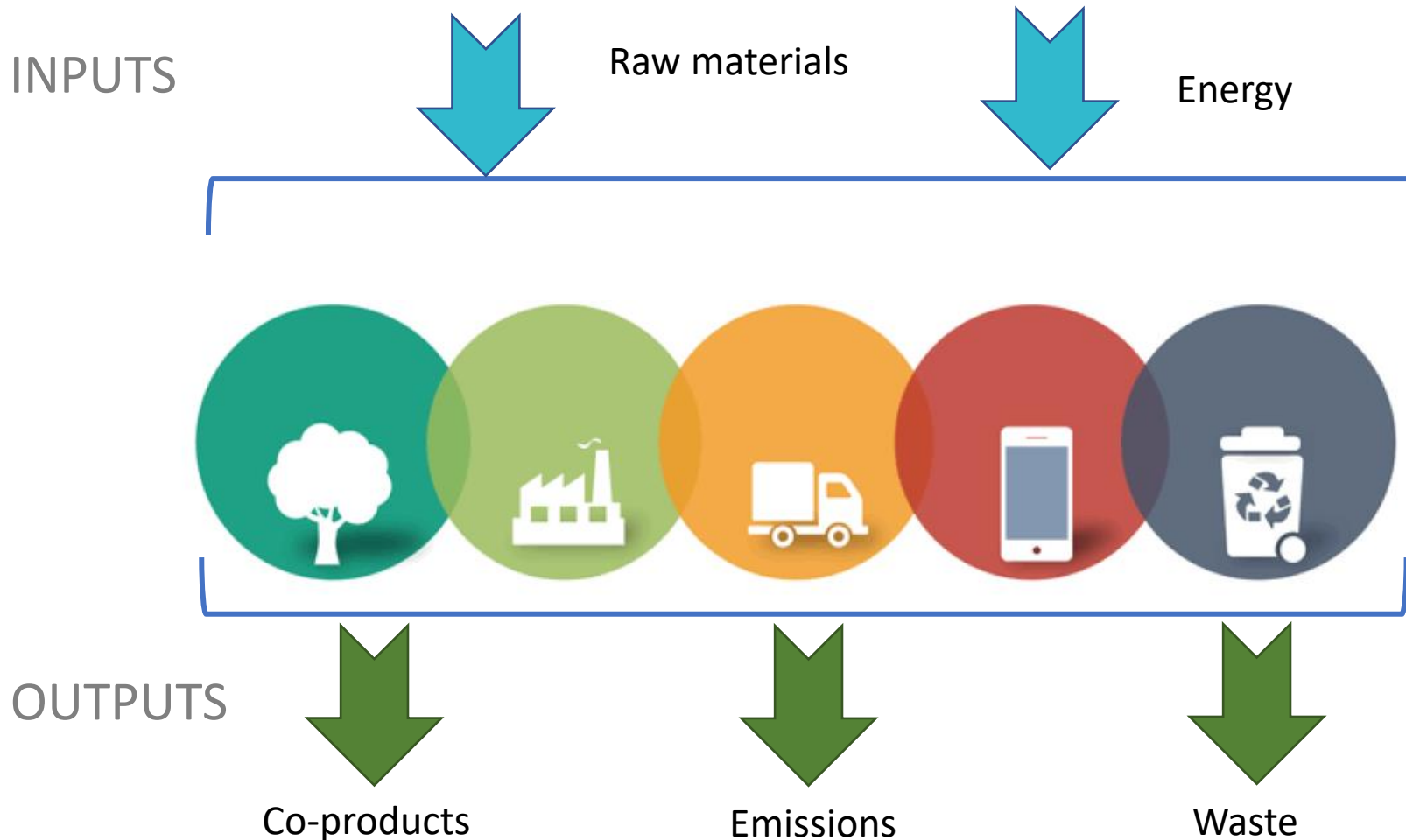
OBJECTIVES

➢ To provide information, as complete, objective and transparent as possible, on the interactions of the product, process or activity with the environment.

➢ Contribute to understanding all the interdependent environmental consequences of human activities.

➢ Anticipate negative consequences of decision-making and identify opportunities for environmental improvements.

➢ Facilitate constructive dialogue between different sectors of society concerned with environmental quality.

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OBJECTIVES

DECISION-MAKING CONTEXTS	STRATEGIC DECISIONS
ADMINISTRATION	• Support for legislation • Eco-labelling • Recommendations to consumers • Green public procurement • Support for infrastructure decision making (waste management, energy production...) • Identification of research areas
COMPANIES	• Ecodesign • Material selection • Process improvement • Supplier selection • Business strategies • Marketing information • Environmental product declarations
NGO	• Political vigilance • Consumer information • Challenging unfounded opinions

STAGES OF LCA

DEFINITION AND DESCRIPTION OF THE PHASES OF A LCA

Methodology for implementing ISO 14040:2006.

This is an environmental assessment methodology that allows the environmental aspects and potential impacts of a product or service to be analysed and quantified throughout its life cycle, i.e. all stages of its existence. Focused on :

- The identification of opportunities to improve the environmental performance of the product in the design and development phases.

- Prioritisation in strategic product planning.

- The choice of environmental performance indicators, including measurement techniques, should include.

- Implementing green marketing strategies.

STAGES OF LCA

DEFINITION AND DESCRIPTION OF THE PHASES OF A LCA

Methodology for implementing ISO 14040:2006.

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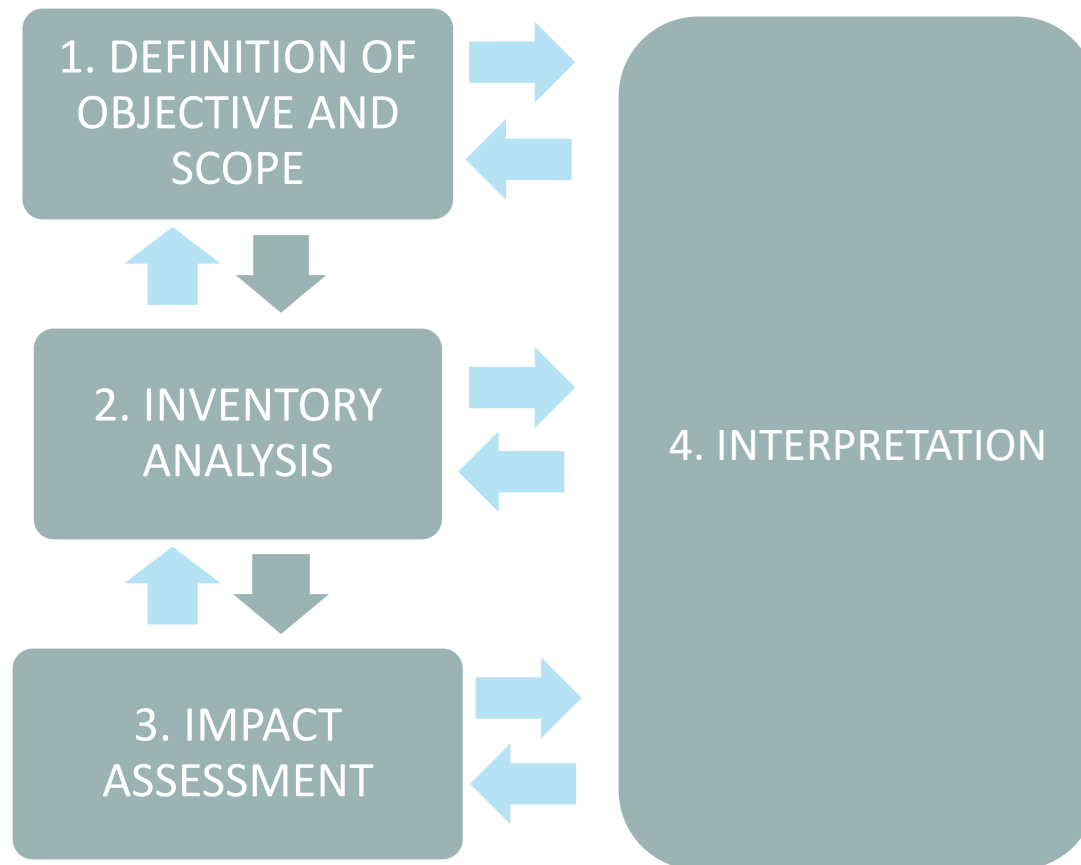
STAGES OF LCA

DEFINITION AND DESCRIPTION OF THE PHASES OF A LCA

➤ **Definition of Objectives and Scope:** Defines the objective and intended use of the study, as well as the scope according to the system boundaries, the functional unit and flows within the life cycle, the required data quality, and the technological and evaluation parameters.

➤ **Development of the Life Cycle Inventory (LCI):** This is the phase of the LCA in which data is collected on the inputs and outputs for all processes of the product system.

➤ **Life Cycle Impact Assessment (LCIA):** is the phase of the LCA in which the inventory of inputs and outputs is transferred to indicators of potential environmental impacts to the environment, human health and natural resource availabilitys.

➤ **Interpretation:** This is the phase of the LCA in which the results of the LCI and LCIA are interpreted according to the objective and scope initially set. In this phase, an analysis of the results is carried out and conclusions are drawn.

LCA CALCULATION STAGES
SCHEME

```
                                              ┌─── OBJECTIVE OF THE STUDY ───┬─ APPLICATION
                                              │                              ├─ MOTIVES
                                              │                              └─ PUBLIC
DEFINITION OF THE OBJECTIVE AND SCOPE ────────┤
                                              │
                                              └─── SCOPE OF THE STUDY ───────┬─ FUNCTION AND FUNCTIONAL UNIT
                                                                             ├─ SYSTEM LIMITS
                                                                             ├─ DATA QUALITY REQUIREMENTS
                                                                             ├─ COMPARISONS BETWEEN SYSTEMS
                                                                             └─ CONSIDERATIONS ON CRITICAL REVIEW

                            ┌─── OVERVIEW OF THE LIFE CYCLE INVENTORY
INVENTORY ANALYSIS ─────────┤
                            └─── DATA COLLECTION AND CALCULATION PROCEDUREO ── ALLOCATION PROCEDURE
                                                                               ENERGY FLOW CALCULATION

IMPACT ASSESSMEN ─── CLASSIFICATION, CHARACTERISATION, (STANDARDISATION), VALUATION (WEIGHTING)

LIFE CYCLE INTERPRETATION
```

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ISO 14040 DEFINITIONS

➢ **Functional unit:** Quantitatively defines the function that a product has, so that it is used as a reference unit in the study (ISO 14040:2006).

➢ **Reference Flow:** Quantity of product required to satisfy the functional unit (ISO 14040:2006).

➢ **Unit process:** Smallest part of a product system from which data are obtained for an LCA (ISO 14040:2006).

➢ **Process tree:** Flow diagram of each stage of a product life cycle in which elementary flows are identified (Suppen, Van Hoof, 2006).

➢ **Allocation:** Partitioning of the inputs or outputs of a process according to the product system of interest (ISO 14040:2006).

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ISO 14040 DEFINITIONS

➢ **Cut-off rule:** Specification of the magnitude of the elementary flux or level of environmental significance associated with a unit process that when met can be excluded in the study (ISO 14040:2006).

➢ **Uncertainty analysis:** Systematic procedure to quantify the uncertainty introduced into the results of an inventory analysis due to the accumulation of inaccuracies in the input data (ISO 14040:2006).

➢ **Characterisation factors:** Values derived from a characterisation model that are applied to transform the result of an Inventory Analysis to the common units of an impact category (ISO 14040:2006).

➢ **Impact category:** A classified environmental problem, to which the possible effect of the study results is assigned (Suppen, Van Hoof, 2006).

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ECO-LABELLING

APPLICATION OF ACV IN CONSTRUCTION

▶ Method for assessing and reducing the environmental impacts of a product.

▶ Environmental management tool to facilitate decision making :

• SCIENCE-BASED USER INFORMATION.

• VOLUNTARY EVALUATION PROCESS.

• JUSTIFY A LOWER ENVIRONMENTAL IMPACT THAN OTHER SIMILAR PRODUCTS.

• SPAIN:

     - AENOR EPD (Global EPD).

     - DAP construction (ITEC and COAAT Barcelona).

     - OPENDAP (Torroja Institute).

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ECO-LABELLING

- **TYPE I (ISO 14024) 14024): ECO-LABELS**

- Third-party verified.

- Issued by a governmental or non-profit body.

- Useful for consumer products.

- Can use LCA to establish performance thresholds to be met for different product categories.

- **TYPE II (ISO 14021): ENVIRONMENTAL SELF-DECLARATIONS**

- Manufacturer's declarations.

- Low credibility.

- Provides information on only one environmental aspect.

- **TYPE III (ISO 14025): ENVIRONMENTAL DECLARATIONS**

- Made by third parties.

- Based onUNE-EN ISO 14040 → LCA.

- They are the most appropriate for CONSTRUCTION PRODUCTS.

- Environmental Declaration for Construction Products.

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ENVIRONMENTAL PRODUCT DECLARATIONS (EPDs)

An EPD can therefore be classified as an "Ecolabel", although its main difference compared to the other systems regulated by the ISO 14020 family of standards (ecolabels and environmental self-declarations) lies in the fact that an EPD does not define environmental requirements or minimum values to be met (there is no list of environmental requirements that the product must meet to be certified), but it shows the results of the LCA study carried out on the certified product in order to provide an image of the product's environmental performance.

Therefore, the fact that a product has an EPD does not mean that it is environmentally better or worse than another product that does not have one, because the purpose of an EPD is not to identify environmentally friendly products: its purpose is to provide information on the environmental performance of the product to allow comparisons with other similar products. It is a detailed report with highly technical information, not simply a symbol or logo.

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ENVIRONMENTAL PRODUCT DECLARATIONS (EPDs)

ENVIRONMENTAL IMPACT ASSESSMENT INDICATORS PROVIDED IN THE DAP:

▶ **Environmental impacts:**

- Global Warming Potential (GWP), kgCO2eq.

- Ozone Depletion Potential (ODP), kgCFC-11eq.

- Acidification Potential of Soil and Water Resources(AP), kgSO2eq

- Eutrophication Potential (EP), kgPO4 eq.

- Tropospheric Ozone Formation Potential (POPC), kg C2H4 eq.

- Abiotic Resource Depletion Potential for Non-Fossil Resources (ADP-elements), kg Sb eq.

- Abiotic Resource Depletion Potential for Fossil Resources (ADP-fossil fu), MJ.

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ENVIRONMENTAL PRODUCT DECLARATIONS (EPDs)

ENVIRONMENTAL IMPACT ASSESSMENT INDICATORS PROVIDED IN THE DAP:

▶ **Resource use:**

• Renewable primary energy use, MJ.

• Non-renewable primary energy use, MJ.

• Secondary material use, kg.

• Renewable secondary fuel use, MJ.

• Non-renewable secondary fuel use, MJ.

• Net use of tap water resources, m3.

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ENVIRONMENTAL PRODUCT DECLARATIONS (EPDs)

ENVIRONMENTAL IMPACT ASSESSMENT INDICATORS PROVIDED IN THE DAP:

▶ **Waste category:**

• Hazardous waste landfilled, kg/UF.

• Non-hazardous waste landfilled, kg/UF.

• Radioactive waste landfilled, kg/UF.

▶ **Other output streams:**

• Components for reuse, kg/UF.

• Materials for recycling, kg/UF.

• Materials for energy recovery (energy recovery), kg/UF.

• Exported energy (electrical, thermal, etc.), kg/UF.

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ENVIRONMENTAL PRODUCT DECLARATIONS (EPDs)

Indicators of life cycle

Indicator ^	Direction ^	Unit ^	Production A1-A3	Transport A4	Installation A5	De-construction C1	Transport C2	Waste processing C3	Disposal C4	Recycling Potential D	Recycling Potential D S1
Renewable primary energy as energy carrier (PERE)	Input	MJ	243	3.1	0.0559	0.271	0.725	2.28	1.7	-5.45	-3.78
Renewable primary energy resources as material utilization (PERM)	Input	MJ	0	0	0	0	0	0	0	0	0
Total use of renewable primary energy resources (PERT)	Input	MJ	243	3.1	0.0559	0.271	0.725	2.28	1.7	-5.45	-3.78
Non renewable primary energy as energy carrier (PENRE)	Input	MJ	1.59E+3	53.3	0.0559	4.66	12.5	27.1	12.9	-19.1	-15.1
Non renewable primary energy as material utilization (PENRM)	Input	MJ	1.23	0	0	0	0	0	0	0	0
Total use of non renewable primary energy resources (PENRT)	Input	MJ	1.59E+3	53.3	0.0559	4.66	12.5	27.1	12.9	-19.1	-15.1
Use of secondary material (SM)	Input	kg	142	0	0	0	0	567	0	0	0

EXAMPLE OF ENVIRONMENTAL IMPACT ASSESSMENT INDICATORS IN EPD.

Source: www.eco-platform.org

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Use of renewable secondary fuels (RSF)	Input	MJ	0	0	0	0	0	0	0	0	0
Use of non renewable secondary fuels (NRSF)	Input	MJ	0	0	0	0	0	0	0	0	0
Use of net fresh water (FW)	Input	m^3	0.205	0.00278	0.00405	0.000243	0.00065	0.00709	0.00326	0.00354	-0.00206
Hazardous waste disposed (HWD)	Output	kg	0.00168	0.00000205	2.28E-10	1.74E-7	4.66E-7	5.7E-7	1.08E-7	-3.6E-7	-7.95E-9
Non hazardous waste disposed (NHWD)	Output	kg	7.84	0.00962	0.00761	0.000818	0.00219	0.00815	35.7	-11.2	-0.00712
Radioactive waste disposed (RWD)	Output	kg	0.0288	0.0000577	0.0000081	0.00000491	0.0000131	0.000217	0.0000796	-0.000712	-0.000548
Components for re-use (CRU)	Output	kg	0	0	0	0	0	0	0	0	0
Materials for recycling (MFR)	Output	kg	0	0	0	0	0	567	0	0	0
Materials for energy recovery (MER)	Output	kg	0	0	0	0	0	0	0	0	0
Exported electrical energy (EEE)	Output	MJ	0	0	3.42	0	0.05	0	0	0	0

EXAMPLE OF ENVIRONMENTAL IMPACT ASSESSMENT INDICATORS IN EPD.

Source: www.eco-platform.org

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ENVIRONMENTAL PRODUCT DECLARATIONS (EPDs)

Exported thermal energy (EET)	Output	MJ	0	0	7.88	0	0.11	0	0	0	0

Core environmental impact indicators

Indicator ⌃	Unit ⌃	Production A1-A3	Transport A4	Installation A5	De-construction C1	Transport C2	Waste processing C3	Disposal C4	Recycling Potential D	Recycling Potential D S1
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC11-Äq.	2.91E-11	1.01E-15	-1.59E-14	8.61E-17	2.3E-16	6.11E-15	2.03E-15	-2.07E-14	-1.61E-14
Eutrophication potential aquatic freshwater (EP-freshwater)	kg PO_(4)-Äq.	0.00014	0.00000899	-0.00000217	7.64E-7	0.00000204	0.00000343	9.32E-7	-0.00000441	-0.0000022
Acidification potential of land and water (AP)	mol H^(+)-Äq.	0.279	0.00383	-0.000866	0.00173	0.000871	0.0135	0.00388	-0.00461	-0.00116
Formation potential of tropospheric ozone photochemical oxidants (POCP)	kg NMVOC-Äq.	0.135	0.00315	-0.000881	0.00228	0.000717	0.0193	0.00302	-0.00414	-0.00101
Global Warming Potential biogenic (GWP-biogenic)	kg CO_(2)-Äq.	0.291	0.00166	-0.0039	-0.0156	0.000377	-11.5	-0.0429	-0.00909	-0.00439
Eutrophication potential aquatic marine (EP-marine)	kg N-Äq.	0.0473	0.00119	-0.000329	0.000816	0.000271	0.00664	0.000999	-0.00175	-0.000375

EXAMPLE OF ENVIRONMENTAL IMPACT ASSESSMENT INDICATORS IN EPD.

Source: www.eco-platform.org

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Water use (WDP)	m^(3) Welt-Äq. entzogen	4.89	0.0178	0.161	0.00151	0.00404	0.242	0.0565	-0.0355	-0.012
Eutrophication potential terrestrial (EP-terrestrial)	mol N-Äq.	1	0.0145	-0.00265	0.00904	0.00329	0.073	0.011	-0.0192	-0.004
Global Warming Potential total (GWP-total)	kg CO_(2)-Äq.	146	4.15	0.824	0.352	0.942	-10.1	0.5	-1.46	-1.06
Global Warming Potential fossil fuels (GWP-fossil)	kg CO_(2)-Äq.	145.6	4.13	0.83	0.366	0.938	1.44	0.541	-1.45	-1.05
Abiotic depletion potential for fossil resources (ADPF)	MJ	1.58E+3	54.8	-14.9	4.66	12.5	27.1	6.9	-19.1	-15.1
Abiotic depletion potential for non fossil resources (ADPE)	kg Sb-Äq.	0.0000162	3.43E-7	-2.25E-7	2.92E-8	7.79E-8	0.00000158	4.88E-8	-3.14E-7	-2.28E-7
Global Warming Potential luluc (GWP-luluc)	kg CO_(2)-Äq.	0.0795	0.0173	-0.00132	0.00147	0.00392	0.00529	0.00156	-0.00484	-0.00135

EXAMPLE OF ENVIRONMENTAL IMPACT ASSESSMENT INDICATORS IN EPD.

Source: www.eco-platform.org

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ENVIRONMENTAL PRODUCT DECLARATIONS (EPDs)

Additional environmental impact indicators

Indicator ▲	Unit ▲	Production A1-A3	Transport A4	Installation A5	De-construction C1	Transport C2	Waste processing C3	Disposal C4	Recycling Potential D	Recycling Potential D S1
Incidence of disease due to PM emissions (PM)[2]	Krankheitsfälle	ND	ND	ND	ND	ND	ND	ND	ND	ND
Human exposure efficiency relative to U235 (IR)[1]	kBq U235-Äq.	ND	ND	ND	ND	ND	ND	ND	ND	ND
Comparative toxic unit for ecosystems (ETP-fw)[2]	CTUe	ND	ND	ND	ND	ND	ND	ND	ND	ND
Comparative toxic unit for humans (noncarcinogenic) (HTP-nc)[2]	CTUh	ND	ND	ND	ND	ND	ND	ND	ND	ND
Soil quality index (SQP)[2]	SQP	ND	ND	ND	ND	ND	ND	ND	ND	ND
Comparative toxic unit for humans (carcinogenic) (HTP-c)[2]	CTUh	ND	ND	ND	ND	ND	ND	ND	ND	ND

[1] This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

[2] The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experiences with the indicator.

EXAMPLE OF ENVIRONMENTAL IMPACT ASSESSMENT INDICATORS IN EPD.

Source: www.eco-platform.org

LCA APPLIED TO THE BUILDING

DEFINITION AND DESCRIPTION OF THE PHASES OF AN ACV APPLIED TO THE BUILDING. UNE-EN 15804

▶ **Methodology for the application of UNE-EN 15804. Sustainability in construction. Environmental product declarations. Basic product category rules for construction products.**

This European standard establishes the Product Category Rules (PCR) for Type III environmental declarations for any construction product and service.

SUSTAINABILITY IN CONSTRUCTION. ASSESSMENT OF THE ENVIRONMENTAL PERFORMANCE OF BUILDINGS. CALCULATION METHODS. UNE-EN 15978:2012
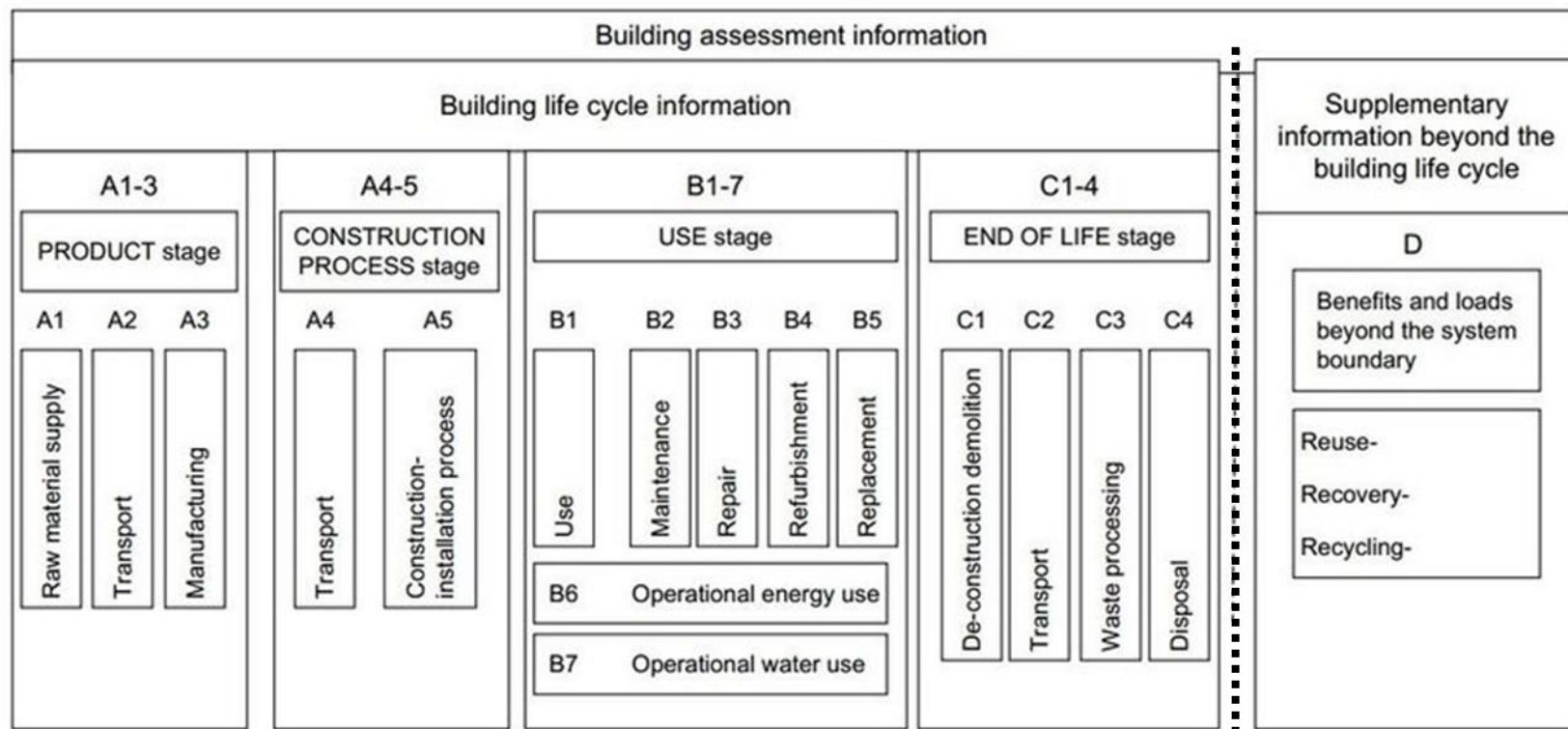
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LCA APPLIED TO THE BUILDING
DEFINITION AND DESCRIPTION OF THE PHASES OF AN ACV APPLIED TO THE BUILDING. UNE-EN 15804

Building assessment information					
Building life cycle information					Supplementary information beyond the building life cycle
A1-3 PRODUCT stage	A4-5 CONSTRUCTION PROCESS stage	B1-7 USE stage	C1-4 END OF LIFE stage		D
A1 Raw material supply / A2 Transport / A3 Manufacturing	A4 Transport / A5 Construction-installation process	B1 Use / B2 Maintenance / B3 Repair / B4 Refurbishment / B5 Replacement / B6 Operational energy use / B7 Operational water use	C1 De-construction demolition / C2 Transport / C3 Waste processing / C4 Disposal		Benefits and loads beyond the system boundary / Reuse- Recovery- Recycling-

EPD		A1-3	A4-5	B1-7	C1-4	D
	Cradle to door (declared unit)	Mandatory			**No RSL**	
	Cradle to door with options (declared unit/ functional unit)	Mandatory	Optional inclusion 1) 2)	Optional inclusion 1) 2)	Optional inclusion 1)	**RSL** if all scenarios 2) occur	Optional inclusion
	Cradle to grave (functional unit)	Mandatory	Optional inclusion 1) 2)	Optional inclusion 1) 2)	Optional inclusion 1)	**RSL** if all scenarios 2) occur	Optional inclusion

1.3. BIM basics applied to LCA

CURRENT SITUATION

CHARACTERISTICS OF BIM IN ACV CALCULATION

EMERGING SOFTWARE LINKED TO BIM

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CURRENT SITUATION

Environmental problems arising from the construction sector require tools to evaluate proposals that help to curb the consumption of resources and environmental impact.

Life Cycle Assessment (LCA) is recognised as one of the most valid methods for the environmental analysis of buildings, although its application is complex and its standardisation and simplification is necessary to make it operational, also in the design phase.
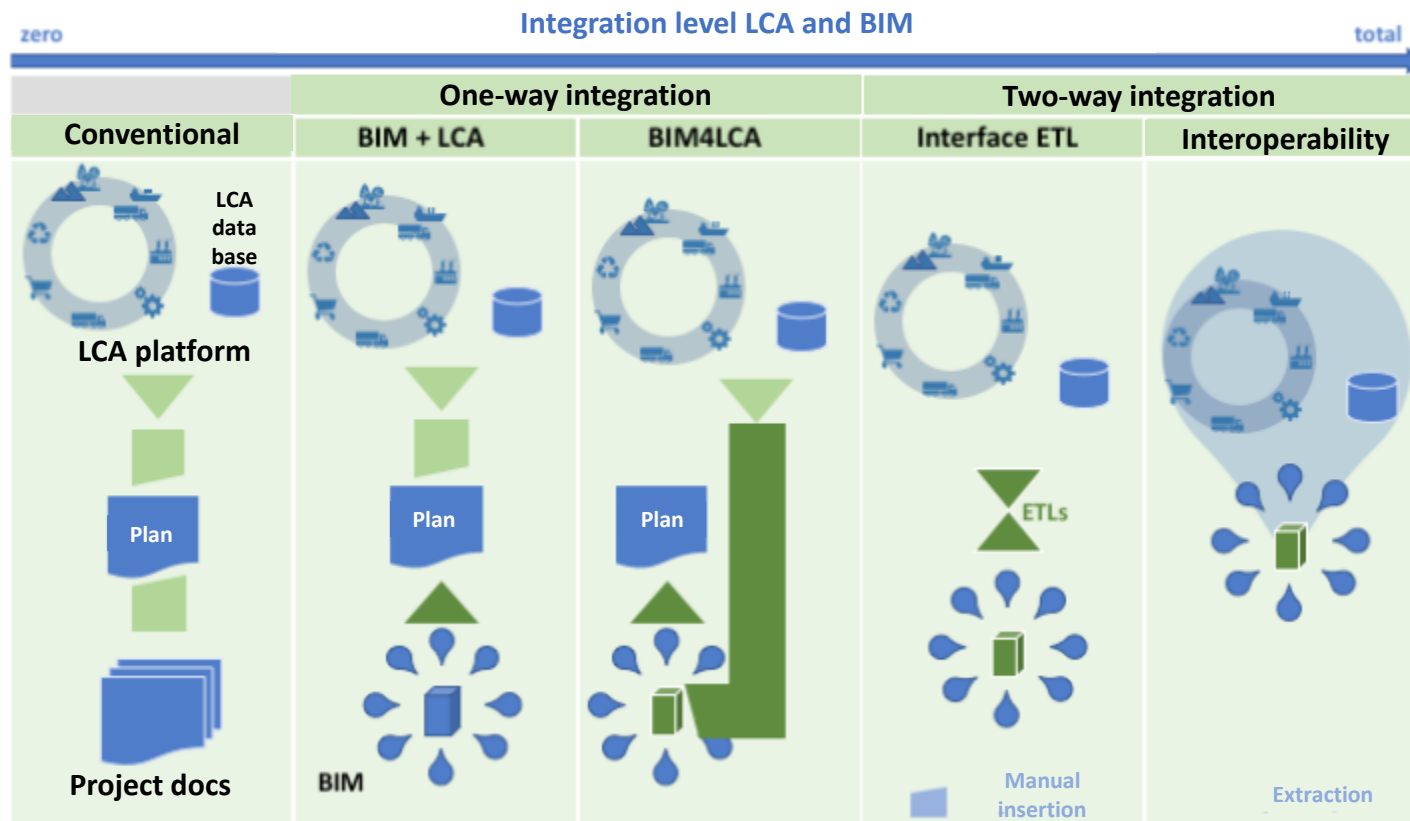
The integration of LCA into BIM platforms simplifies the environmental impact assessment process. Currently, there is a scarcity of literature and development of simulation tools based on BIM models and linked to LCA for obtaining environmental impact results.

It is therefore necessary to standardise LCA implemented in BIM platforms in order to simplify the process and obtain environmental impact results in real time from the design phase.

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CURRENT SITUATION

Today, the LCA of the building is unfortunately not a factor of choice, but rather an outcome. It is still difficult for the actors involved in a building project to rely on LCA in their choices. However, developers of BIM software and solutions will play an important role in integrating LCA into digital models.

Integration level LCA and BIM

zero → total

Conventional	One-way integration		Two-way integration	
	BIM + LCA	BIM4LCA	Interface ETL	Interoperability

LCA data base

LCA platform

Plan · BIM · Project docs · ETLs · Manual insertion · Extraction

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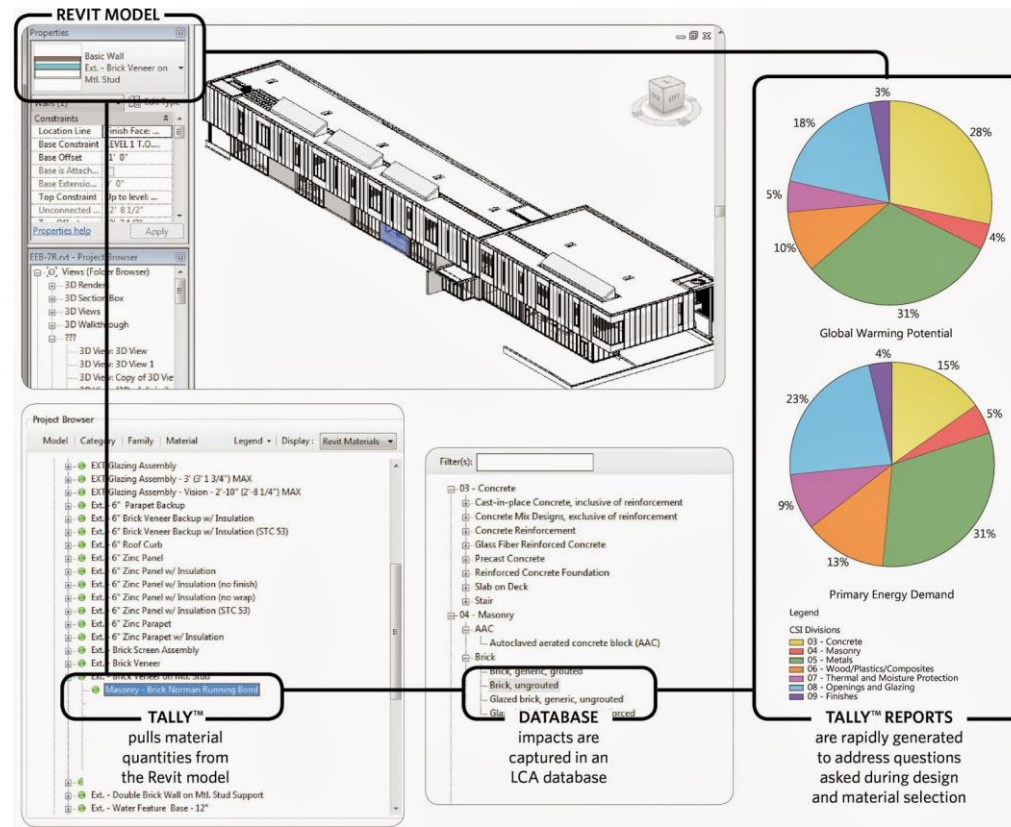# CHARACTERISTICS OF BIM IN ACV CALCULATION

From a building modelled in BIM it is possible to calculate the LCA potentially without even changing the software environment. Therefore, LCA in BIM should be more automatic, more systematic and easier to achieve, allowing multidisciplinary teams in architectural projects to establish different scenarios from the point of view of the environmental impact of the building.

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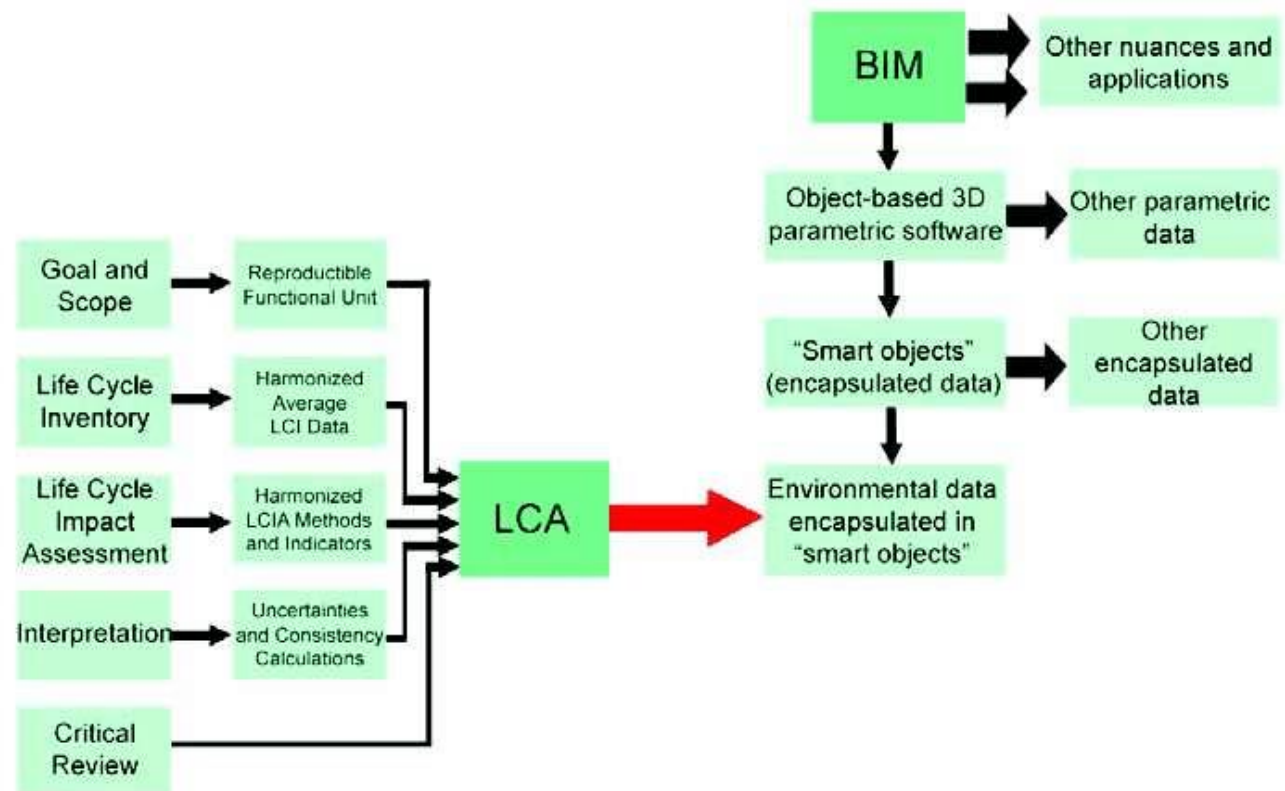
EMERGING SOFTWARE LINKED TO BIM

▶ **Tally.** Add-in application for Autodesk Revit that allows to calculate the environmental impact of the construction materials of the whole building, as well as to perform comparative analysis of the design options. While working on the REVIT model, the user can define the relationships between BIM elements and building materials from the Tally database resulting in the LCA of the building.

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EMERGING SOFTWARE LINKED TO BIM

▶ **One Click LCA.** It is the highest rated LCA tool for BREEAM, compatible with several BREEAM schemes: BREEAM UK, BREEAM NOR, BREEAM SE, BREEAM NL, BREEAM ES, BREEAM DE.
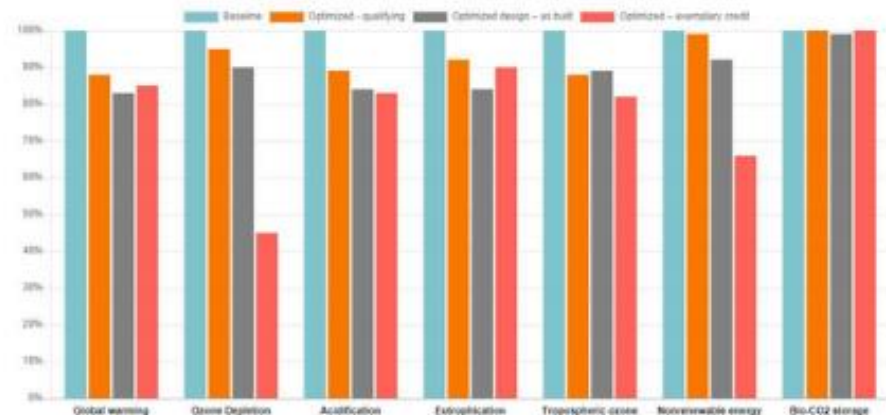

EMBODIED CARBON FROM CRADLE TO GRAVE

- A1-A3 Materials- 89 %
- A4 Transportation- 4 %
- B4-B5 Replacement- 4 %
- C1-C4 End of life- 3 %

EMBODIED CARBON BY STRUCTURE

- Foundations and substructure - 13%
- Vertical structures and facade - 28%
- Horizontal structures: beams, floors and roofs - 33%
- Other structures and materials - 26%

COMPARE DESIGN'S LIFE CYCLE IMPACT

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EMERGING SOFTWARE LINKED TO BIM

▶ **One Click LCA. <u>Integration with other software</u>.**

- IFC — Industry Foundation Classes, the international standard (ISO 16739) for BIM. Support for IFC 2x3 and IFC4.

- Autodesk Revit versions 2016, 2017, 2018, 2019, and 2020 — native plugin watch the video.

- IES-VE version 2017 Feature Pack 4 or higher watch the video.

- ArchiCAD native 18-19, higher versions via IFC or Excel.

- Tekla Structures 2016 — native plugin, higher versions via IFC.

- simplebim and Naviate Simple BIM 5.0 and upwards.

- DesignBuilder 5.1. and upwards.

- Excel and CSV formats — enabling easy import of quantity take-offs or costing data.

- gbXML — the industry standard for sharing data for energy analysis software packages. Supported e.g. by IES-VE.

- Solibri Model Checker 9.8 and higher watch the video.

- IDA ICE (version 4.8 SP1).

- Bentley AECOsim via IFC.

- SketchUp Pro via IFC.

- Custom integrations from XML, JSON, web services and other sources.

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SOURCES

BIM Methodology. *https://www.buildingsmart.es/bim/*

https://www.kaizenai.com/bim/que-es-el-bim/

Dimensions of BIM. *https://storage.googleapis.com/wzukusers/user-33893552/images/5b8922d869f31HaEK1lJ/Las-Dimensiones-de-BIM.png*

BIM implementation. *https://www.buildingsmart.es/bim/*

Software BIM. *https://www.bimnd.es/tipo-software-bim-en-cada-fase/*

Use Autodesk® Revit in Spain. *https://www.espaciobim.com/software-bim-mas-utilizado-revit*

Norma ISO 14040. *https://envira.es/es/iso-14040-principios-relacionados-gestion-ambiental/*

Environmental Product Declarations. Sustainable Insulation. ISOVER.
https://www.isover.es/sites/isover.es/files/assets/documents/dap-oct-2015.pdf

EN 15804:2008 Sustanibility of construction Works – Environmental product declarations – Core rules for the Product Category of Construction Products. *https://www.une.org/encuentra-tu-norma/busca-tu-norma/norma?c=N0052571*

LCA implementation in BIM platform - Source : Márcio Minto Fabricio *https://www.researchgate.net/figure/LCA-implementation-in-BIM-platform-Source-AuthorselaborationAuthorselaboration_fig1_311557520*

Current situation.
https://www.researchgate.net/publication/325435242_Contribuicao_da_modelagem_BIM_para_facilitar_o_processo_de_ACV_de_edificacoes_completas

Characteristics of BIM in the LCA calculation *https://www.bimandco.com/es/blog/25-what-role-does-bim-play-today-in-lca*