UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Course guide
310777 - 310777 - Lca in Building

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Unit in charge: Barcelona School of Building Construction
Teaching unit: 753 - TA - Department of Architectural Technology.

Degree: BACHELOR'S DEGREE IN ARCHITECTURAL TECHNOLOGY AND BUILDING CONSTRUCTION (Syllabus 2019). (Optional subject).

Academic year: 2026 **ECTS Credits:** 3.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: Calderón Peñafiel, Juan Carlos

Others: Alfaro Garrido, Licinio José

PRIOR SKILLS

1. General transversal skills

Ability to analyse, synthesise and apply critical thinking to the environmental assessment of buildings.

Ability to organise and plan individual and team work, especially in activities based on data, calculations and progressive submissions.

Ability to communicate technical information orally, in writing and graphically, in order to explain environmental results clearly, rigorously and understandably.

Ability to interpret technical information from different sources and assess its quality, coherence and limitations.

Environmental awareness and professional commitment regarding the impact of the building sector on resource consumption, greenhouse gas emissions and waste generation.

Critical attitude towards unverified environmental claims, avoiding simplifications, inappropriate comparisons or conclusions without quantitative support.

2. Specific skills

a) Cognitive skills

Basic knowledge of common building materials, products and construction systems.

General understanding of the construction process and the main stages in the life cycle of a building: material production, transport, construction, use, maintenance, replacement and end of life.

Initial knowledge of the concepts of environmental impact, sustainability, embodied carbon, operational carbon and decarbonisation of the building sector.

Basic understanding of the units of measurement used in building and environmental assessment: m^2, m^3, kg, functional units and impact indicators.

b) Procedural and instrumental skills

Ability to interpret technical documentation for products and construction systems, including technical data sheets, bills of quantities, budgets, catalogues and environmental product declarations.

Ability to transform geometric and construction data into basic environmental inventory quantities.

Basic use of spreadsheets to organise data, apply impact factors, perform simple calculations and represent results.

Ability to search for, select and cite technical and environmental information sources appropriately.

Ability to compare construction alternatives in a simplified way, maintaining coherence between the functional unit, system boundaries, data used and results obtained.

c) Aptitudes and attitudes

Willingness to work with incomplete or heterogeneous data, always declaring the assumptions, uncertainties and limitations of the study.

Rigour and honesty in the treatment of environmental data, avoiding the uncritical use of generic values or unverifiable results.

Interest in integrating environmental criteria into decision-making related to design, construction and material selection.

Open attitude towards autonomous learning and iterative review of results.

Commitment to the responsible use of information, source traceability and academic integrity.

REQUIREMENTS

Basic technical English, especially for reading and understanding environmental documentation, articles, standards, databases and Environmental Product Declarations (EPD).

Basic use of spreadsheets to organise data, perform simple calculations, apply impact factors and present results.

Basic knowledge of construction and building materials, sufficient to interpret construction solutions, quantity take-offs and technical documentation.

Basic ability to work with the virtual learning environment and submit activities in digital format.

TEACHING METHODOLOGY

Demonstrative lectures: Short sessions to introduce the fundamentals of Life Cycle Assessment (LCA) applied to building, including life cycle thinking, the definition of the functional unit, system boundaries, life cycle modules, environmental indicators and the interpretation of results.

Active learning: Exercises and micro-workshops focused on the development of a basic environmental inventory, the critical reading of Environmental Product Declarations (EPD), the application of impact factors and the simplified comparison of construction alternatives.

Case-study-based work: Progressive development of an applied building or construction system case study, in which students must define the goal and scope of the study, quantify materials, select environmental data, calculate impacts and interpret the results obtained.

Autonomous learning: Consultation of bibliography, standards, databases, EPD and technical documentation to complete the inventory, justify the assumptions adopted and improve the quality of the data used in the study.

Group work: Development of an integrative exercise comparing a conventional solution with an improved alternative, assessing environmental impact hotspots and the possibilities for reducing embodied carbon.

Cooperative learning and peer review: Comparison of inventories, system boundaries, data sources and results among students or teams, with the aim of detecting inconsistencies, improving traceability and strengthening the methodological quality of the LCA.

Data and results visualisation workshop: Use of spreadsheets and graphic resources to organise data, represent impacts by phases or construction systems, identify hotspots and communicate results clearly and rigorously.

Technical debate and defence of results: Presentation and discussion of the results obtained, justifying methodological decisions, assumptions, study limitations and recommendations for environmental improvement.

LEARNING OBJECTIVES OF THE SUBJECT

Reducing the environmental impact of the building sector requires the incorporation of environmental assessment criteria from the early stages of design, material selection, definition of construction systems and decision-making on site. In this context, Life Cycle Assessment (LCA) is a fundamental tool for quantifying impacts, comparing alternatives and guiding environmental improvement strategies with a methodological basis and quantitative support.

The course introduces the fundamentals of LCA applied to building, with particular attention to the definition of the goal and scope of the study, the functional unit, system boundaries, life cycle modules, inventory development, selection of environmental data and interpretation of results. Special emphasis will be placed on the GWP (Global Warming Potential) indicator, expressed in kg COâ□□-eq, as the main indicator for analysing embodied carbon and comparing construction solutions.

The course adopts an applied and progressive approach. Students will develop a simplified LCA study of a building, building element or construction system, using data from Environmental Product Declarations (EPD), databases, technical literature and other justified sources. Emphasis will be placed on methodological coherence, data traceability, declaration of assumptions and the ability to interpret results in order to make technical and environmental decisions.

The general objective of the course is to enable students to understand, apply and communicate the basic principles of LCA in the field of building, using them as a support tool for decision-making in design, construction and the selection of materials and construction systems.

By the end of the course, students will be able to:

Understand the role of LCA in the environmental assessment of buildings and its relationship with the decarbonisation of the sector.

Differentiate between embodied carbon and operational carbon, and recognise the main life cycle stages of a building or construction system.

Define the goal and scope of a simplified LCA study, establishing a coherent functional unit, justified system boundaries and appropriate comparability criteria.

Identify and interpret the life cycle modules applicable to building, including product, construction, use, maintenance, replacement, end-of-life stages and benefits or loads beyond the system boundary, where applicable.

Develop a basic environmental inventory based on quantity take-offs, geometric data, material characteristics and construction processes.

Select, interpret and use environmental data from EPD, databases, technical literature or duly justified generic values.

Calculate, in a simplified way, the environmental impacts associated with materials and construction systems, especially GWP expressed in kg COâ□□-eq.

Identify the environmental impact hotspots of a building, element or construction system, distinguishing the components or stages that have the greatest weight in the final result.

Compare construction alternatives using equivalent criteria, avoiding unjustified conclusions or methodologically inconsistent comparisons.

Analyse the sensitivity of results to changes in data, assumptions, transport scenarios, waste factors, service life or end-of-life scenarios.

Propose environmental improvement strategies aimed at reducing embodied carbon and the impacts associated with the building life cycle.

Communicate the results of an LCA study clearly, concisely and graphically, declaring sources, assumptions, uncertainties and limitations.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	10,0	13.33
Self study	45,0	60.00
Hours large group	20,0	26.67

Total learning time: 75 h

CONTENTS

M1. Fundamentals of LCA in building

Description:
M1.1 Life cycle thinking applied to building: Introduction to the concept of the life cycle and its usefulness for assessing design decisions, material selection and construction systems.

M1.2 Environmental impacts in the building sector: Resource consumption, greenhouse gas emissions, waste generation, and the relationship between embodied carbon and operational carbon.

M1.3 Introduction to Life Cycle Assessment (LCA): Purpose of LCA, main stages of the study and simplified application to buildings, building elements or construction systems.

M1.4 Goal, scope and functional unit: Definition of the study goal, functional unit, system boundaries and basic comparability criteria between alternatives.

M1.5 Life cycle modules in building: Introduction to modules A1–A5, B, C and D, with particular attention to the product, construction and end-of-life stages. Module D will be treated as separate information when applicable.

Specific objectives:
By the end of the module, students will be able to:

Explain the role of life cycle thinking in the environmental assessment of buildings.
Differentiate between embodied carbon and operational carbon.
Recognise the basic stages of an LCA study.
Define a simple functional unit and coherent system boundaries.
Identify the main life cycle modules applicable to buildings and construction systems.

Related activities:
M1 A1 — Class: Guided introduction to life cycle thinking.

Brief exercise to identify the life cycle stages of a building or construction system, differentiating between production, transport, construction, use, maintenance and end of life.

M1 A2 — Workshop: Definition of the goal, scope and functional unit.

Guided application to a simple building case. Students will define the study goal, functional unit, system boundaries and basic comparability criteria.

M1 A3 — Autonomous work: Introductory reading and synthesis.

Brief reading on LCA, embodied carbon and life cycle modules. Preparation of an operational synthesis with the key concepts applicable to the case study.

Full-or-part-time: 20h
Theory classes: 6h
Guided activities: 3h
Self study : 11h

M2. Inventory, environmental data and simplified calculation

Description:
M2.1 Basic environmental inventory: Transformation of geometric data, quantity take-offs and construction characteristics into useful quantities for LCA: m^2, m^3, kg and equivalent units.

M2.2 Sources of environmental data: Basic reading and interpretation of Environmental Product Declarations (EPD), databases, technical literature and justified generic values.

M2.3 Impact factors and GWP indicator: Simplified application of impact factors to calculate Global Warming Potential (GWP), expressed in kg COâ□□-eq.

M2.4 Assumptions, scenarios and data quality: Declaration of basic assumptions related to transport, waste factors, service life, replacement and end of life. Identification of limitations and uncertainties.

M2.5 Development of a simplified LCA matrix: Organisation of data in a spreadsheet to obtain results by material, element, system or life cycle stage.

Specific objectives:
By the end of the module, students will be able to:

Develop a basic environmental inventory from construction information.
Interpret environmental data from EPD and other justified sources.
Apply impact factors coherently with the functional unit and system boundaries.
Calculate, in a simplified way, the GWP associated with materials or construction systems.
Document the main assumptions, sources and limitations of the study.

Related activities:
M2 A1 — Class: Critical reading of EPD.

Guided analysis of an Environmental Product Declaration to identify the declared unit, included modules, GWP indicator, conditions of use, representativeness and data limitations.

M2 A2 — Workshop: Development of the environmental inventory.

Transformation of quantity take-offs and geometric data of a construction element or system into useful quantities for environmental calculation. Unit conversion and coherence between m^2, m^3, kg and the functional unit will be addressed.

M2 A3 — Workshop: Simplified GWP calculation.

Application of impact factors to the environmental inventory using a spreadsheet. Obtaining partial and total results in kg COâ□□-eq.

M2 A4 — Autonomous work: Simplified LCA matrix.

Preparation of a calculation matrix including data, sources, assumptions, impact factors and results. Students must document the sources used and declare the main limitations.

Full-or-part-time: 30h
Theory classes: 6h
Guided activities: 6h
Self study : 18h

M3. Interpretation, comparison and environmental improvement

Description:
M3.1 Reading results and identifying hotspots: Interpretation of LCA results to detect the materials, systems or stages that concentrate the highest environmental impact.

M3.2 Comparison of construction alternatives: Simplified comparison between a conventional solution and an improved alternative, maintaining equivalent criteria for the functional unit, system boundaries and data sources.

M3.3 Sensitivity and uncertainty: Basic analysis of how results may vary according to the assumptions adopted, especially transport, waste factors, service life, replacement or end-of-life scenarios.

M3.4 Environmental improvement strategies: Identification of possible impact reduction actions, such as material optimisation, product substitution, use of lower-impact materials, reuse, recycling or improved durability.

M3.5 Communication of results: Preparation of a concise report and graphical representation of results, declaring sources, assumptions, limitations and main conclusions.

Specific objectives:
By the end of the module, students will be able to:

Interpret the results of a simplified LCA applied to building.
Identify environmental impact hotspots in materials, systems or life cycle stages.
Compare construction alternatives using methodologically coherent criteria.
Recognise the influence of the main assumptions on the results.
Propose reasoned environmental improvements based on the results obtained.
Communicate the results, limitations and conclusions of the study clearly and graphically.

Related activities:
M3 A1 — Class: Interpretation of results and identification of hotspots.

Analysis of the results obtained in the LCA matrix to identify the materials, elements or stages with the greatest contribution to total GWP.

M3 A2 — Workshop: Comparison between a conventional and an improved alternative.

Simplified comparison between two equivalent construction solutions. The coherence of the functional unit, system boundaries, data sources and comparability criteria will be reviewed.

M3 A3 — Autonomous work: Environmental improvement proposal.

Definition of an improved alternative based on the hotspots detected. The proposal may incorporate quantity reduction, material substitution, improved durability, reuse, recycling or other justified strategies.

M3 A4 — Workshop and defence: Communication of results.

Preparation of a concise report and graphical representation of the results. Brief defence of the case study, explaining data, assumptions, limitations, comparison of alternatives and main conclusions.

Full-or-part-time: 25h
Theory classes: 4h
Guided activities: 5h
Self study : 16h

ACTIVITIES

name english

Full-or-part-time: 3h
Theory classes: 3h

name english

Full-or-part-time: 2h
Practical classes: 2h

name english

Full-or-part-time: 15h
Self study: 15h

name english

Full-or-part-time: 5h
Theory classes: 5h

name english

Full-or-part-time: 3h
Practical classes: 3h

name english

Full-or-part-time: 3h
Practical classes: 3h

name english

Full-or-part-time: 19h
Self study: 19h

name english

Full-or-part-time: 4h
Theory classes: 4h

name english

Full-or-part-time: 2h
Practical classes: 2h

name english

Full-or-part-time: 11h
Self study: 11h

name english

Full-or-part-time: 8h
Theory classes: 8h

GRADING SYSTEM

Assessment is continuous and based on progressive evidence linked to the development of a simplified Life Cycle Assessment (LCA) study applied to building. No final theoretical exam is planned: the final grade is obtained from the submissions, the methodological quality of the work, data traceability, and the ability to interpret and communicate the results obtained.

Assessment components

E1 — Definition of the study and critical reading of environmental data — 25%

Individual work or work in small groups. Definition of the goal and scope of the study, functional unit, system boundaries and comparability criteria. It includes the critical reading of one or more Environmental Product Declarations (EPD), assessing the declared unit, the modules included, data representativeness, conditions of use and limitations of the available information.

E2 — Environmental inventory and simplified impact calculation — 35%

Individual work or work in small groups. Development of the basic inventory of materials and processes for a selected building, building element or construction system. The coherence of quantity take-offs, unit conversion, selection of impact factors, calculation of GWP in kg COâ□□-eq and correct documentation of the assumptions adopted will be assessed.

E3 — Comparison of alternatives, interpretation and technical defence — 40%

Integrative work. Comparison between a conventional solution and an improved alternative, identifying environmental impact hotspots, opportunities for reducing embodied carbon, sensitivity of the results and limitations of the study. It includes a concise final report, graphical representation of the results and a brief technical defence.

Calculation of the final grade

Final grade = $(E1 \times 0.25) + (E2 \times 0.35) + (E3 \times 0.40)$

Minimum requirements to pass

To pass the course, students must:

— Obtain a final grade equal to or higher than 5.0.

— Submit the three assessment components: E1, E2 and E3.

— Obtain a minimum grade of 5.0 in E3, given its integrative nature.

— Participate in the workshop activities, peer review and technical defence linked to the development of the case study.

Cross-cutting criterion: traceability of data and assumptions

All submissions will assess the traceability of the data used, correct citation of sources, coherence of assumptions and explicit statement of the study limitations. Lack of traceability, uncritical use of generic data or the presence of methodological inconsistencies may lead to penalties. If lack of verification prevents the work from being reviewed, the submission may be considered invalid.

Submission and course rules

Submissions must be made exclusively through the virtual campus. Late submissions will not be accepted, except in duly justified cases of force majeure.

Group work and individual contribution

When activities are carried out in groups, the team must document the contribution of its members to the tasks of inventory development, data search, calculation, interpretation and communication of results. The teaching staff may adjust the individual grade if significant imbalances in participation or authorship are detected.

Academic integrity and use of digital tools

The origin of each environmental data item must be cited, and relevant assumptions must be declared, such as transport, waste factors, service life, end-of-life scenarios or sources of impact factors. The use of digital tools or artificial intelligence must be declared when it has contributed to the writing, organisation or processing of information, and may not replace calculation, technical justification or critical analysis of the results.

Reassessment / resit

Given the continuous assessment nature of the course, based on progressive submissions and the development of an applied case study, no resit exam is planned. Passing the course depends on the complete and verifiable submission of the assessment evidence and on the technical defence of the integrative work.

EXAMINATION RULES.

Continuous assessment

The course is assessed through a continuous assessment system based on the progressive development of a simplified Life Cycle Assessment (LCA) study applied to building. No independent final theoretical exam is planned.

Requirements to be assessed

In order to be assessed, students must submit the main assessment evidence for the course within the established deadlines and participate in the activities linked to the case study, especially workshops, peer reviews and the final technical defence.

Submissions

Submissions must be made exclusively through the virtual campus, in the format and within the deadline indicated by the teaching staff. Late submissions will not be accepted, except in duly justified cases of force majeure.

Validity of submissions

A submission may be considered invalid if it does not include the minimum information required to verify the work carried out: definition of the goal and scope, functional unit, system boundaries, data sources, assumptions adopted, main calculations and results obtained.

Traceability of data and sources

All environmental data used must be correctly referenced. The origin of Environmental Product Declarations (EPD), databases, impact factors, generic values or any other source used must be indicated. Lack of traceability or the use of unjustified data may lead to penalties.

Methodological coherence

Studies must maintain coherence between the functional unit, system boundaries, inventoried quantities, impact factors and results presented. Comparisons between alternatives will only be valid if they are made using equivalent and duly justified criteria.

Group work and authorship

When activities are carried out in groups, all members must contribute to the development of the work. The teaching staff may request evidence of individual contribution and adjust the grade if significant imbalances in participation, authorship or responsibility in the submitted work are detected.

Academic integrity and use of digital tools

The sources used must be cited and the relevant assumptions of the study must be declared. The use of digital tools or artificial intelligence must be declared when it has contributed to the writing, organisation, review or processing of information. These tools cannot replace calculation, technical justification or critical analysis of the results.

Technical defence

The technical defence of the integrative work forms part of the assessment. In this defence, students must justify the methodological decisions adopted, explain the main results, acknowledge the limitations of the study and answer questions about the data, assumptions and conclusions.

Reassessment / resit

Given the continuous assessment nature of the course, no resit exam is planned. Passing the course depends on the complete, coherent and verifiable submission of the established assessment evidence.

BIBLIOGRAPHY

Basic:

- UNE-EN ISO 14040:1998: gestión medioambiental: análisis de ciclo de vida: principios y estructura. Madrid: AENOR, 1998.
- Life Cycle Assessment: Theory and Practice [on line]. Cham: Springer International Publishing, 2018 [Consultation: 30/06/2026]. Available on: https://discovery.upc.edu/permalink/34CSUC_UPC/i7glq6/alma991005191167106711.
- UNE-EN ISO 14044: gestión ambiental: análisis del ciclo de vida: requisitos y directrices. Madrid: Asociación Española de Normalización y Certificación, 2006.
- UNE-EN 15804:2012+A1: sostenibilidad en la construcción: declaraciones ambientales del producto: reglas de categoría de producto básicas para productos de construcción. Madrid: Asociación Española de Normalización y Certificación, 2014.
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- König, Holger; Lützkendorf, Thomas; Peat, Raymond. A Life cycle approach to buildings : principles, calculations, design tools [on line]. Munich: Institut für internationale Architektur-Dokumentation, 2010 [Consultation: 30/06/2026]. Available on: https://discovery.upc.edu/permalink/34CSUC_UPC/i7glq6/alma991003870459706711. ISBN 9783920034454.
- McDonough, William; Braungart, Michael; Pérez van Kappel, Gregorio. Cradle to cradle = De la cuna a la cuna : rediseñando la forma en que hacemos las cosas [on line]. Madrid [etc.]: McGraw-Hill, cop. 2005 [Consultation: 30/06/2026]. Available on: https://discovery.upc.edu/permalink/34CSUC_UPC/i7glq6/alma991002824309706711. ISBN 8448142950.