# Teaching Guide

## *Environmental assessment of material resources used in the construction of building*

# Table of contents

# 1. Subject data

| | |
|---|---|
| **Name** | ENVIRONMENTAL ASSESSMENT OF MATERIAL RESOURCES USED IN THE CONSTRUCTION OF BUILDINGS |
| | |
| **Module** | Environmental Engineering and Sustainable Development |
| **Qualification in which it is taught** | * |
| **Other qualifications that could be offered *** | Architecture Degree<br>Engineering of Construction Degree<br>Civil Engineering Degree<br>Public Works Engineering Degree<br>Master's programmes related to (Add more if applicable) |
| **Centre** | * |
| **Character** | OPTIONAL |
| **Term** | Four months |
| **Course** | * |
| **Language** | Official Language* |
| **ECTS** | 3 |
| **ECTS learning hours** | 25 |
| **Overall workload (hours)** | 75 |
| **Theory class schedule** | * |
| **Classroom** | * |
| **Practice class schedule** | * |
| **Place** | * |

(*) All the fields marked with an asterisk are subject to completion with the specific information for each educational centre.

## 2. Teachers data

| | |
|---|---|
| Teacher responsible | * |
| Department | * |
| Area of knowledge | * |
| Teacher's office location | * |
| Phone | * |
| E-mail | * |
| URL / WEB | * |
| Tutorial timetables | * |
| Tutorial location | * |
| Teaching and research profile | * |

(*) All the fields marked with an asterisk are subject to completion with the specific information for each educational centre.

# 3. Description of the subject

## 3.1. Short description of the contents

- Building and Sustainable development.
- Environmental regulation and sustainability in building.
- LCA, CO2 emissions calculation, carbon and ecological footprint methodologies and procedures.
- The use of OERCO2 Tool.

## 3.2. General description of the subject

The term sustainable means that it can stand on its own, without depleting natural resources. A world driven by natural resources, requires good management of them, to achieve what is known as sustainable development or satisfaction of the needs of present generations without compromising the possibilities of the future. Sustainable development encompasses three factors, society, economy and environment. To achieve the objective of sustainable development, societies need to develop a series of tools that are undoubtedly the product of research, development and adaptation of the human being to the environment.

In this subject, sustainable processes in the construction industry are known and studied, understood as those that consume less raw materials, energy and produce less waste, thus producing a lower environmental impact and preserving economic resources.

To do this, the following methodologies will be studied within the normative frame of reference, for the quantification of the environmental impact generated by construction.

**1. Life Cycle Analysis (LCA)** is a process that allows us to evaluate the environmental burdens associated with a product, process or activity, identifying and quantifying both the use of matter and energy as waste and emissions to the environment, to determine the impact of that use of resources and to evaluate and implement environmental improvement strategies. It includes the complete cycle of the product, process or activity, taking into account the stages of extraction and processing of raw materials, production, transport and distribution, use, reuse and maintenance, recycling and landfill disposal at the end of its useful life.

**2. CO2 emissions, carbon and ecological footprint**, are direct indicators of the impacts that buildings generate on the environment. The objective is to know the different calculation methodologies to quantify the impact and to reduce it, from the conception of the building, through design, construction, its useful life and demolition.

The use of tools is an attractive part of the analysis of environmental problems arising from construction, which require specific techniques. Often, it is necessary to use them in order to obtain the information required to solve an analysis problem. This subject aims to teach the operation of the OERCO2 tool, for the calculation of the total emissions of the building.

## 3.3. Objectives of the subject

1. Adequate knowledge of physical problems and of different technologies, as well as the function of buildings, to provide them with internal conditions of comfort, healthiness and protection of climatic factors.

2. Ability to design the requirements of building users to meet them, respecting the limits imposed by budgetary factors and construction regulations, and in relation to bioclimatic and sustainability aspects.

3. Knowledge of the mechanisms that favour the recovery, reuse and recycling of construction materials.

4. Knowledge and ability to design an architecture that minimizes the waste generated in the construction of the building.

5. Train the student to acquire a critical and scientific way of thinking, to be able to apply the offered technologies to their constructive solution, to respond to the demands of citizens regarding sustainability and to protect the environment during the construction process.

6. Teach the basic operation of the OERCO2 tool, as a professional instrument to evaluate the environmental impacts of products, processes and services.

7. Acquire the necessary basic knowledge of LCA, and analyse the databases and impact assessment methodologies available to perform a LCA.

8. Make practical cases that support learning.

9. Present the foundations and the environmental regulations that pertain to constructive development.

10. Teach the operation of the OER platform, as an online resource center for self-learning in performance methodologies for sustainable development in construction.

## 3.4. Contribution of the subject to professional practice

This subject aims to raise awareness among future professionals about the need to adequately foresee the negative consequences that human actions may have on the environment during the development of a specific project, ranging from the stage of previous studies to the rehabilitation phase or dismantling. In it, students will be provided with the necessary knowledge to develop and apply tools for analysis, decision making, prevention, correction, mitigation, etc., of the negative effects that a specific construction project may cause.

Currently, with the legislative changes that have taken place in recent years, some preventive tools have been included in other environmental permits or authorizations, although they play an essential role in minimizing environmental problems.

On the other hand, we must highlight the set of measures that allow us to correctly manage the different environmental aspects of a specific activity, which will allow us to comply with current environmental legislation, as well as achieve levels of environmental excellence.

## 3.5. Recommendations to course the subject

(*) Completion subject to the criteria of the educational centre.

## 3.6. Special measures provided

(*) Specific regulations of the educational centre with respect to the establishment of special adaptations in the methodology and the development of teachings for students who suffer some type of disability or limitation.

# 4. Competencies and learning outcomes

## 4.1. Basic competences

BC1. Possess and understand knowledge that provides a basis or opportunity to be original in the development and / or application of ideas, often in a research context.

BC2. That students know how to apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.

BC3. That students know how to communicate their conclusions and the knowledge and ultimate reasons that sustain them to specialized and non-specialized audiences in a clear and unambiguous way.

BC4. That students have the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

BC5. That students have the ability to gather and interpret relevant data to make judgments that include a reflection on relevant issues of a social, scientific or ethical nature.

## 4.2. General competences

GC1. That the students have demonstrated a detailed and well-founded understanding of the theoretical and practical aspects and the methodology of work in the field of Environmental Engineering and Sustainable Processes.

GC2. That students are able to predict and control the evolution of complex situations through the development of new and innovative work methodologies adapted to the field of Environmental Engineering and Sustainable Processes.

GC3. Be able to take responsibility for their own professional development and their specialization in one or more fields in the field of Environmental Engineering and Sustainable Processes.

GC4. Be able to foster, in professional contexts, the technological, social or cultural advancement within a society based on knowledge.

GC5. Be able to take responsibility for their own professional development and their specialization in one or more fields of study.

## 4.3. Specific competences

SC1. Know the principles of sustainable development applied to engineering and construction, and the rules that affect the environment.

SC2. Know the procedures related to energy efficiency.

SC3. Knowledge of the impact of the building sector in the achievement of sustainable development and, especially, deepening knowledge of the regulations on the environmental impact of the building.

SC4. Intensification in techniques for assessing the environmental impact of building and demolition processes, the sustainability of buildings, and their relationship with the energy efficiency of buildings.

SC5. Know the different tools of environmental management, as well as its correct application to reduce environmental problems.

SC6. Plan the implementation of an environmental management system, as well as its maintenance.

## 4.4. Transversal competences

TC1. Aptitude for the written and oral communication, as well as for the analysis, organization, planning and synthesis that provides sufficiency or suitability in the critical reasoning.

TC2. Ability to manage computer tools that allow data management, problem solving and help decision making.

TC3. Aptitude for teamwork, interdisciplinary, that combines interpersonal skills while maintaining respect for diversity, such as coexistence with other cultures.

TC4. Ability to acquire criteria of continuous training, adaptability to social transformations, motivation for quality from creativity.

TC5. Ability to reconcile environmental requirements with the conditions of development.

TC6. Ability to apply ethical criteria and sustainability in decision making.

## 4.5. Learning outcomes

1. Know the different tools of environmental management, differentiating those of a mandatory nature from those of a voluntary nature.

2. Identify and assess the different environmental aspects in a constructive process.

3. Know the different concepts of the field of sustainability.

4. Know the sustainable construction and the life cycle analysis.

5. Understand sustainability as a new culture.

6. Be able to develop a bioclimatic project, taking into account the design, new technologies, and its functionality.

7. Develop the capacity for environmental evaluation of construction projects, and the capacity for self-criticism.

8. Know the different European environmental specific regulations in the field of construction.

9. Know methodologies for calculating environmental impact to be able to develop an environmentally optimized construction project.

# 5. Contents

## 5.1. Contents of the subject

Environmental legislation and sustainability in construction. Preventive tools of environmental impact study. Generation of alternatives. Methodologies for environmental impact assessment. Construction and sustainable development. Analysis of the project and alternatives. Identification and assessment of impacts.

## 5.2. Theory programme (sessions and issues)

BLOCK I: CONSTRUCTION AND ENVIRONMENT

UNIT 1. Introduction

1.1 Concepts. Introduction to sustainability. Environment.

1.2 Regulatory context of sustainable development and environmental quality.

1.3 Introduction to environmental analysis in construction.

1.4 Sustainability in construction: Regulations.

1.5 Status of the level of implementation of sustainable construction.

BLOCK II: SUSTAINABILITY IN CONSTRUCTION

UNIT 2. Life cycle analysis (LCA) for construction.

2.1 Definition and scope.

2.2 Normative frame of refere3nce for LCA.

2.3 Definition and presentation of the different phases of a LCA.

2.4 Application to the construction sector.

2.5 LCA examples.

UNIT 3. Materials

3.1 Manufactured materials and their raw materials.

3.2 European Products Directive.

3.3 Environmental labels and Environmental Product Declarations (EPD).

UNIT 4. Methodologies for calculating environmental impact in construction.

4.1 Methodologies for calculating CO2.

4.2 Methodologies for calculating carbon and ecological footprint.

4.3 Influence of reuse and recycling processes.

4.4 Examples of quantification of environmental impact.

UNIT 5. Calculation Tool (OERCO2)

5.1 Analysis of a practical case study.

5.2 Use of OERCO2 Tool.

5.3 Application of the practical case to the tool OERCO2.

5.4 Analysis and study of results.

5.5 Constructive alternatives to reduce the environmental impact.

5.6 Comparative study of the different constructive solutions.

## 5.3. Practices programme

Realization of 4 practical cases of 4 different building typologies.

# 6. Teaching methodology

| 6.1. Teaching methodology | | | |
|---|---|---|---|
| **Activity** | **Teaching techniques** | **Student's work** | **Hours** |
| **Theoretical classes** | Expositive classes of the theoretical contents, using the method of lesson dialogue. Resolution of doubts raised by students. | On-site: | **12** |
| | | Non-on-site: | 0 |
| **Solution of problems and practical cases** | Resolution of practical cases. Problems are posed to students for their resolution in the classroom at a certain time. They are solved through the use of blackboard and / or projector. Proposition of exercises for resolution at home. | On-site: | **3** |
| | | Non-on-site: | 2 |
| **Practices in computer classroom** | Search for information, management of databases and use of tools for calculating and estimating emissions. | On-site: | 0 |
| | | Non-on-site: | 4 |
| Cooperative work activities | Resolution of practical cases. Working groups will be set up in the classroom to carry out practices, monitoring the participation of the group's members. | On-site: | **3** |
| | | Non-on-site: | 2 |
| Tutorials | Resolution of doubts about theory, problems, practices and seminars. | On-site: | 0 |
| | | Non-on-site: | 3 |
| Seminars and visits to companies and facilities | In the seminars, specific topics of the theoretical syllabus will be expanded. Depending on availability, a visit will be made or the assistance of an environmental management professional will be scheduled. | On-site: | **3** |
| | | Non-on-site: | 0 |
| Work / Individual study | Study of the subject. | On-site: | 0 |
| | | Non-on-site: | 25 |
| Works / Informs | Realisation of works and reports of practices to be delivered by the student. | On-site: | 0 |
| | | Non-on-site: | 10 |
| Formative evaluation activities | Follow-up and development of works, practices and reports. | On-site: | 0 |
| | | Non-on-site: | 4 |
| **Official exams** | Preparation, correction and review of written tests. | On-site: | **2** |
| | | Non-on-site: | 0 |
| **Exhibition of Works** | Evaluation and correction of the expositions corresponding to the different works to be carried out by the student. | On-site: | **2** |
| | | Non-on-site: | 0 |
| | | | **75** |

# 7. Assessment methodology

| 7.1. Activities and assessment criteria | | |
|---|---|---|
| **Activities** | **Systems and assessment criteria** | **Percentage Weight (%)** |
| Written tests. | Theoretical-practical knowledge acquired by the student will be evaluated. | 60 |
| Assessment of practices cases with ICT support. | Knowledge acquired in practices with ICT support will be evaluated. | 0-5 |
| Individual and teamwork assessment works. | Development and presentations of individual and group works will be evaluated. | 30 |
| Other assessment activities. | Attendance and participation to classes of the subject will be evaluated. | 5-10 |
| Works | | |
| Individual and teamwork works. | All aspects related to the task to be carried out will be evaluated, from the search of information to the final presentation. | 40 |
| Resolution of practical cases. | Both the proposed solution and the analysis of alternatives and the justification of the solutions that have been carried out will be evaluated. | 20 |
| Assessment of practices cases with ICT support. | Knowledge acquired in practices with ICT support will be evaluated. | 0-5 |
| Individual and teamwork assessment works. | Development and presentations of individual and group works will be evaluated | 30 |
| Other assessment activities. | Attendance and participation to classes of the subject will be evaluated. | 5-10 |

## 7.2. Control and monitoring mechanism

The control and monitoring of student learning will be done through the following actions:

- Participation in the issues and practical cases raised in class.

- Assistance to theoretical and practical classes.

- Tutorials.

- Carrying out self-evaluation questionnaires.

- Assessment of the individual written test, or of the research works, individual and in group.

# 8. Bibliography and resources

## 8.1. Bibliography

Cioca, L.I., Codoi, M.V. The impact of carbon footprinting in Romania. In The 6th Balkan Region Conference on Engineering and Business Education. Sibiu. 2012.

González Vallejo, Patricia, Solís Guzmán, Jaime, Llácer Pantión, Rafael, Marrero Meléndez, Madelyn: La construcción de edificios residenciales en España en el período 2007-2010 y su impacto según el indicador Huella Ecológica. En: Informes de la Construcción. 2015. Vol. 67. Núm. 539. http://dx.doi.org/10.3989/ic.14.017

González Vallejo, Patricia, Marrero Meléndez, Madelyn, Solís Guzmán, Jaime: The ecological footprint of dwelling construction in Spain. En: Ecological Indicators. 2015. Núm. 52. Pag. 75-84. 10.1016/j.ecolind.2014.11.016

Guía sobre declaración ambiental de producto y cálculo de huella de carbono. 2014. Fundación de la Energía de la Comunidad de Madrid.

La declaración ambiental de producto. 1.ª edición. Enero 2015. Ihobe, Sociedad Pública de Gestión Ambiental. Departamento de Medio Ambiente y Política Territorial. Gobierno Vasco.

Marica, S., Cetean, V., & Lazaroiu, G. Unitary management and environmental performance by monitoring and protection of mineral resources for construction materials from Romania. Building and Environment, 43(6), 1082–1090. 2008.

Marrero Meléndez, Madelyn, Puerto, Manuel, Rivero Camacho, Cristina, Freire Guerrero, Antonio, Solís Guzmán, Jaime: Assessing the economic impact and ecological footprint of construction and demolition waste during the urbanization of rural land. En: Resources, Conservation and Recycling. 2017. Vol. 117. Núm. Part B. Pag. 160-174. http://dx.doi.org/10.1016/j.resconrec.2016.10.020

Marrero M, Martínez-Escobar L, Mercader-Moyano MP, Leiva-Fernández C. Minimización del Impacto Ambiental en la Ejecución de Fachadas Mediante el Empleo de Materiales Reciclados / Environmental impact minimization of façade construction through recycled materials use. Inf Constr 2013; 65(529):89–97

Martínez Rocamora, Alejandro, Solís Guzmán, Jaime, Marrero Meléndez, Madelyn: Ecological footprint of the use and maintenance phase of buildings: Maintenance tasks and final results. En: Energy And Buildings. 2017. Vol. 155. Pag. 339-351. 10.1016/j.enbuild.2017.09.038

Martínez Rocamora, Alejandro, Solís Guzmán, Jaime, Marrero Meléndez, Madelyn: LCA databases focused on construction materials: A review. En: Renewable & Sustainable Energy Reviews. 2016. Vol. 58. Pag. 565-573. 10.1016/j.rser.2015.12.243

Martínez Rocamora, Alejandro, Solís Guzmán, Jaime, Marrero Meléndez, Madelyn: Toward the Ecological Footprint of the use and maintenance phase of buildings: Utility consumption and cleaning tasks. En: Ecological Indicators. 2016. Vol. 69. Pag. 66-77. 10.1016/j.ecolind.2016.04.007

Simion, I. M., Ghinea, C., Maxineasa, S. G., Taranu, N., Bonoli, A., & Gavrilescu, M. Ecological footprint applied in the assessment of construction and demolition waste integrated management. Environmental Engineering and Management Journal, 12(4), 779-788. 2013.

Solís Guzmán, Jaime, Marrero Meléndez, Madelyn: Ecological Footprint Assessment of Building Construction. Bentham Science Publishers. 2015. 162. ISBN 978-1-68108-099-4

Solís Guzmán, Jaime, Marrero Meléndez, Madelyn, Ramirez de Arellano Agudo, Antonio: Methodology for Determining the Ecological Footprint of the Construction of Residential Buildings in Andalusia (Spain). En: Ecological Indicators. 2013. Núm. 25. Pag. 239-249. http://dx.doi.org/10.1016/j.ecolind.2012.10.008

Solís Guzmán, Jaime, Rivero Camacho, Cristina, Alba Rodríguez, Mª Desirée, Martínez Rocamora, Alejandro: Carbon Footprint Estimation Tool for Residential Buildings for Non-Specialized Users: OERCO2 Project. En: Sustainability. 2018. Vol. 10. Núm. 1359. 10.3390/su10051359

Rastei E., Beu D. Construcții sustenabile. Note de curs (2013).

## 8.2. Regulations

UNE-EN ISO 14025:2010. Environmental labels and declarations. Type III environmental declarations. Principles and procedures.

UNE-EN 15804:2012. Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products.

UNE- EN ISO 14020:2002 Environmental labels and declarations. General principles.

UNE-EN ISO 14040:2006 Environmental management. Life cycle assessment. Principles and framework.

UNE-ISO 14044:2006 Environmental management. Life cycle assessment. Requirements and guidelines.

UNE-EN 15978:2012. Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method.

ISO 15686-5:2008. Buildings and constructed assets. Service life planning. Part 5: Life-cycle costing.

Norma ISO 14001 y EMAS. Community Regulation of Eco-management and Eco-audit.

ISO 14021:2002. Environmental labels and declarations. Self-declared environmental claims (Type II environmental labelling).

ISO 14024:2001. Environmental labels and declarations. Type I environmental labelling. Principles and procedures.

Royal Decree 187/2011 relating to establishment of eco-design requirements for energy-using products - Article 10.

Order VIV/1744/2008, of 9 of June, which regulates General Technical Building Code Registry. Article 2. Organisation.

Decree 21/2006, of 14 of February, which regulates the adoption of environmental criteria and eco-efficiency in buildings - Paragraph 6.2

Royal Decree 105/2008, of 1 of February, which regulates the production and management of construction and demolition waste.

Royal Decree 238/2013, of 5 of April, amending certain Articles and Technical Instruction for the Regulation of Thermal Installations in Buildings, approved by Royal Decree 1027/2007, of 20 of July.

## 8.3. Online resources and other resources

www.oerco2.eu

www.csostenible.net

www.magrama.gob.es

www.codigotecnico.org

Locuințe & Ipoteci Verzi - Ghid Pentru Investitorii și Dezvoltatorii De Clădiri Rezidențiale /

Green Homes & Mortgages - A Toolkit For Residential Investors and Developers