INTELLECTUAL OUTPUT 1

TASK O1-A3

Comparative study on Life Cycle Assessment (LCA) of construction materials for industrial buildings in the participant countries

Erasmus+

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1. INTRODUCTION

This report is included in the task: "*O1-A3. Comparative study on Life Cycle Assessment (LCA) of construction materials for industrial buildings in the participant countries*", corresponding to Intellectual Output 1 "*Establishment of common learning outcomes on industrial areas restoration with new technologies, Life Cycle Assessment (LCA) and relative regulations*" of the RecoverIND project.

A study report with the existing methodologies for calculating LCA of the main materials used in industrial buildings has been carried out for all the participant countries (Romania, Spain and Poland).

This report and all the information about the project are available in the following url:

- RecoverIND project web: https://recoverind.eu/en/project/

2. LIFE CYCLE ASSESSMENT (LCA)

Life cycle assessment is increasingly being used worldwide to quantify the environmental performance of buildings, set impact reduction targets, and ensure a safe environment for future generations.

Life-cycle assessments (LCAs) involve cradle-to-grave analyses of production systems and provide comprehensive evaluations of all upstream and downstream energy inputs and multimedia environmental emissions. LCAs can be costly and time-consuming, thus limiting their use as analysis techniques in both the public and private sectors. Streamlined techniques for conducting LCAs are needed to lower the cost and time involved with LCA and to encourage a broader audience to begin using LCA. It has emerged as a valuable decision-support tool for both policy makers and industry in assessing the cradle-to-grave impacts of a product or process. Three forces are driving this evolution. First, *government regulations* are moving in the direction of "life-cycle accountability;" the notion that a manufacturer is responsible not only for direct production impacts, but also for impacts associated with product inputs, use, transport, and disposal. Second, *business is participating in voluntary initiatives* which contain LCA and product stewardship components. Together these developments have placed LCA in a central role as a tool for identifying cradle-to-grave impacts both of products and the materials from which they are made [3].

The "life-cycle" impacts include the extraction of raw materials; the processing, manufacturing, and fabrication of the product; the transportation or distribution of the product to the consumer; the use of the product by the consumer; and the disposal or recovery of the product after its useful life.

There are four linked components of LCA [3] [5]:

Goal definition and scoping: identifying the LCA's purpose and the expected products of the study and determining the boundaries (what is and is not included in the study) and assumptions based upon the goal definition.

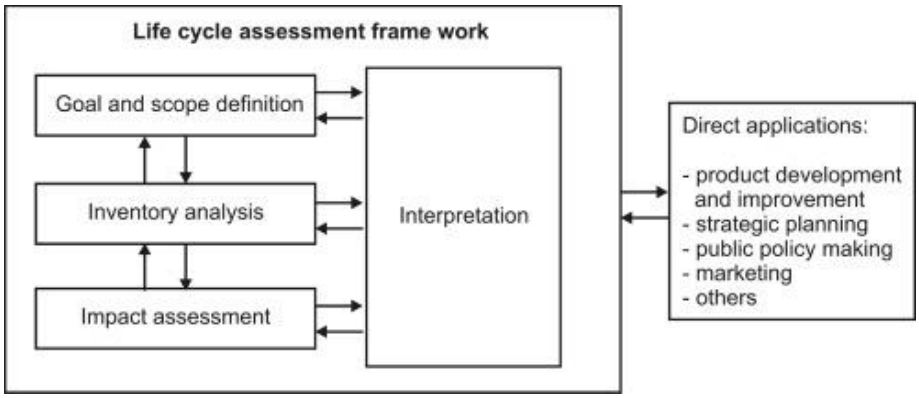

Figure 1 - LCA stages under the ISO 14040 guidelines [2].

Life-cycle inventory: quantifying the energy and raw material inputs and environmental releases associated with each stage of production.

Impact analysis: assessing the impacts on human health and the environment associated with energy and raw material inputs and environmental releases quantified by the inventory.

Improvement analysis: evaluating opportunities to reduce energy, material inputs, or environmental impacts at each stage of the product life cycle.

LCA helps decision-makers select the product, process, or technology that results in the least impact to the environment. This information can be used with other factors, such as cost and performance data to find optimal solutions. LCA identifies the transfer of environmental impacts from one media to another (for instance: a new process may lower air emissions, but creates more wastewater, etc.) and between different lifecycle stages. The diagram below illustrates the main lifecycle stages to be considered in LCA:

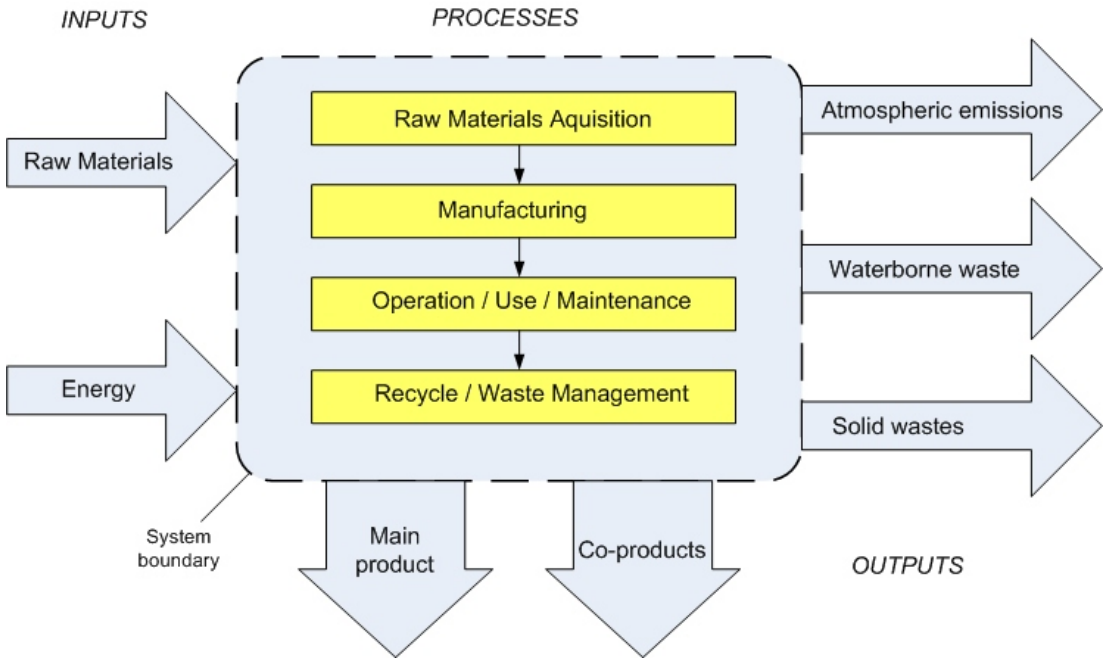

Figure 2 - Main stages and typical inflows and outflows considered in lifecycle assessment [4].

LCA Limitations:

LCA thoroughness and accuracy will depend on the availability of data; gathering of data can be problematic; hence a clear understanding of the uncertainty and assumptions is important.

Classic LCA will not determine which product, process, or technology is the most cost effective or top performing; therefore, LCA needs to be combined with cost analysis, technical evaluation, and social metrics for comprehensive sustainability analysis.

Unlike traditional risk assessment, LCA does not necessarily attempt to quantify any specific actual impacts. While seeking to establish a linkage between a system and potential impacts,

LCA models are suitable for relative comparisons but may be not sufficient for absolute predictions of risks.

When undertaking a life cycle assessment study, the following issues need to be addressed:

The burdens imposed on the environment by human activities may be ascertained by accounting for the resources and energy (inputs) consumed at each stage in the life cycle of a product and the resulting pollutants and wastes (outputs) emitted. The inputs and outputs are then assessed for their adverse impacts on long-term sustainability of renewable and non-renewable resources, human health, and biodiversity, amongst others. Once these are known, measures may be taken to mitigate the impact of the outputs (or inventories) on the environment [2].

The utilization of LCA method can help in the following [2]:

• searching the most available life cycles, e.g., those with minimal negative impact on environment,

• assuming the decisions in industry, public organizations, or NGOs, which determine direction and priorities in strategic planning, design or design product, or process change,

• choose important indicators of environmental behaviour of organization including measurement and assessing techniques, mainly in connection with the assessment of the state of its environment,

• marketing with the link on formulation of environmental declaration or eco-labelling.

2.1 LEGISLATION OF LCA AND ITS APPLICATION IN CONSTRUCTION SECTOR

2.1.1 Romania

Life cycle assessment (LCA), one of the most important instruments that lead to the sustainable development by controlling the CO2 fingerprint of materials or different investments, has a low level of interest for Romanian authorities, in comparison with other European countries. Such evaluation is often content of Environmental Product Declarations (EPD), which for construction products or materials, the private sector tends to show a growing importance. However, there are different initiatives of national interest, promoted by Romanian authorities, that tend to align with European regulations, mostly because obligative reasons. Unfortunately, the way in

which the regulations are applied, are reflecting the lack of experience and consciousness regarding environmental issues, by Romanian authorities.

Applied standards in Romania regarding LCA

Life cycle assessment is established in the national legislation by the international standards listed below:

- SR EN ISO 14021:2016 Environmental labels and declarations -- Self-declared environmental claims (Type II environmental labelling)

Specifies requirements for self-declared environmental claims, including statements, symbols and graphics, regarding products. It further describes selected terms commonly used in environmental claims and gives qualifications for their use. This International Standard also describes a general evaluation and verification methodology for self-declared environmental claims and specific evaluation and verification methods for the selected claims in this International Standard.

- SR EN ISO 14024:2018 Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures

It establishes the principles and procedures for developing Type I environmental labelling programmes, including the selection of product categories, product environmental criteria and product function characteristics, and for assessing and demonstrating compliance. ISO 14024:2018 also establishes the certification procedures for awarding the label.

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

It establishes the principles and specifies the procedures for developing Type III environmental declaration programmes and Type III environmental declarations. It specifically establishes the use of the ISO 14040 series of standards in the development of Type III environmental declaration programmes and Type III environmental declarations. ISO 14025:2006 establishes principles for the use of environmental information, in addition to those given in ISO 14020:2000

- SR EN ISO 14031:2014 - Environmental management -- Environmental performance evaluation – Guidelines

Gives guidance on the design and use of environmental performance evaluation (EPE) within an organization. It is applicable to all organizations, regardless of type, size, location and complexity.

- SR EN ISO 14044: 2007. Environmental management. Life Cycle Assessment. Requirements and guidelines

Specifies requirements and provides guidelines for life cycle assessment (LCA) including definition of the goal and scope of the LCA, the life cycle inventory analysis (LCI) phase, the life cycle impact assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, relationship between the LCA phases, and conditions for use of value choices and optional elements.

It gives guidance on the design and use of environmental performance evaluation (EPE) within an organization. It is applicable to all organizations, regardless of type, size, location and complexity. The guidance in ISO 14031:2013 can be used to support an organization's own approach to EPE, including its commitments to compliance with legal and other requirements, the prevention of pollution, and continual improvement.

- SR EN ISO 14045: 2012 Environmental management. Assessing the eco-efficiency of product systems. Principles, requirements and guidelines

Describes the principles, requirements and guidelines for eco-efficiency assessment for product systems including: the goal and scope definition of the eco-efficiency assessment; the environmental assessment; the product-system-value assessment; the quantification of eco-efficiency; interpretation (including quality assurance); reporting; critical review of the eco-efficiency assessment.

Requirements, recommendations and guidelines for specific choices of categories of environmental impact and values are not included. The intended application of the eco-efficiency assessment is considered during the goal and scope definition phase, but the actual use of the results is outside the scope of ISO 14045:2012.

- ISO/TS 14048:2002 Environmental management. Life Cycle Assessment. Format of the data documentation

This Technical Specification provides the requirements and a structure for a data documentation format, to be used for transparent and unambiguous documentation and exchange of Life Cycle Assessment (LCA) and Life Cycle Inventory (LCI) data, thus permitting consistent documentation of data, reporting of data collection, data calculation and data quality, by specifying and structuring relevant information.

The data documentation format specifies requirements on division of data documentation into data fields, each with an explanatory description. The description of each data field is further specified by the structure of the data documentation format.

- EN 15804 + A1: 2014. Sustainable development of construction works. Product environmental statements. Basic rules for the category of construction products.
- EN 15942: 2012. Sustainability of construction works. Environmental product declarations. Communication format business-to-business.
- SR EN ISO 14040:2007 - Environmental management — Life cycle assessment — Principles and framework

By the essential requirements of “Law 10/1995 regarding quality in building sector”, the seventh one (7. Sustainable use of natural resources) is regulating:

- Buildings must be designed, executed and demolished so that the use of natural resources must be sustainable and in particular to ensure the following:
  a) Reuse or recyclability of buildings, materials and component parts, after demolition.
  b) the durability of constructions.
  c) the use in construction of environmentally compatible raw and secondary materials.

Thus, even though the Romanian regulations for building sector are mentioning the essential requirements, yet there are no specific methodologies for applying them.

The list below refers to other important regulations implying the use or of LCA instrument:

LEGE nr. 50 din 29 iulie 1991 privind autorizarea executării lucrărilor de construcţii - Republicare*)	Law no. 50 of July 29, 1991 regarding the authorization for the execution of construction works - Republished *)
Planul Național de Gestionare a Deșeurilor	National Waste Management Plan
Legea nr. 211/2011 privind gestionarea deşeurilor	Law no. 211/2011 on waste management
Legea nr. 101/2006 a serviciului de salubrizare a localităţilor, cu modificările şi completările ulterioare.	Law no. 101/2006 of the sanitation service of the localities, with subsequently modifications and completions.
HG nr. 445/2009 privind evaluarea impactului anumitor proiecte publice si private asupra mediului	GD no. 445/2009 on the assessment of the impact of certain public and private projects on the environment
Hotărârea Nr. 17 din 11 ianuarie 2012 pentru modificarea şi completarea Hotărârii Guvernului nr. 445/2009 privind evaluarea impactului anumitor proiecte publice şi private asupra mediului	Decision Nr. 17 of 11 January 2012 for amending and completing the Government Decision no. 445/2009 on the assessment of the impact of certain public and private projects, on the environment.
Hotărârea nr. 668/2017 privind stabilirea condițiilor pentru comercializarea produselor pentru construcţii, care înlocuieşte Hotărârea nr. 622/2004 privind stabilirea condițiilor de introducere pe piaţă a produselor pentru construcţii	Decision no. 668/2017 laying down the conditions for the marketing of construction products, which replaces the Decision no. 622/2004 laying down the conditions for the placing on the market of construction products
LEGE nr. 608 din 31 octombrie 2001 privind evaluarea conformităţii produselor	Law no. 608 of 31 October 2001 on conformity assessment of products
Legea nr. 24/1994 pentru ratificarea Convenţiei-cadru a Naţiunilor Unite asupra schimbărilor climatice, semnată la Rio de Janeiro la 5 iunie 1992	Law no. 24/1994 for the ratification of the United Nations Framework Convention on Climate Change signed in Rio de Janeiro on 5 June 1992.
O.G nr. 68/2016 pentru modificarea şi completarea Legii nr. 211/2011 privind regimul deşeurilor	EO no. 68/2016 for amending and completing the Law no. 211/2011 on waste regime.
Hotărârea nr. 204/2013 pentru modificarea şi completarea Hotărârii Guvernului nr. 780/2006 privind stabilirea schemei de comercializare a certificatelor de emisii de gaze cu efect de seră	Decision no. 204/2013 for amending and completing the Government Decision no. 780/2006 on establishing the scheme for greenhouse gas emission allowance trading
Hotărâre nr. 236 din 07/03/2007 privind stabilirea unor măsuri pentru asigurarea aplicării Regulamentului Parlamentului European şi al Consiliului nr. 1980/2000/CE din 17 iulie 2000 privind sistemul revizuit de acordare a etichetei ecologice comunitare	Decision no. 236 of 07/03/2007 on the establishment of certain measures for the enforcement of the Regulation of the European Parliament and of the EU Council no. 1980/2000 / EC of 17 July 2000 on the revised Community eco-label award scheme
Hotărârea nr. 55/2011 privind stabilirea cerinţelor în materie de proiectare ecologică aplicabile produselor cu impact energetic	Decision no. 55/2011 on establishing ecodesign requirements for energy-related products

CRITERII din 14 iulie 2005 de acordare a etichetei ecologice pentru grupul de produse materiale pentru pardoseli rigide	CRITERIA of 14 July 2005 on the award of the eco-label to the rigid flooring material group

Different professional associations or non-governmental organisations (NGO's) promote implementation of international legislation adapted to Romanian realties that confront with important issues regarding environment and sustainable policies.

2.1.2 Poland

According to the Polish standard PN-EN ISO 14044 from 2009, is defining as "Collecting and evaluating inputs, outputs and potential environmental influences product system during its life cycle ". The inputs are quantitative and qualitative data on the resources and energy used to carry out the process being analyzed. The effect of this process, i.e. both desirable products, services as well as emissions and waste are the outputs. The product system is understood as a set of material and energetically connected processes unitary or its smallest parts. The product system has of course, the boundaries set by the designer within which LCA study is making, where different production processes can be assessed or individual stages of technology. It is not possible to cut off impacts that are not significant for the study (those with a small contribution to the overall environmental impact). The boundaries the product system is shown in the below diagram below.

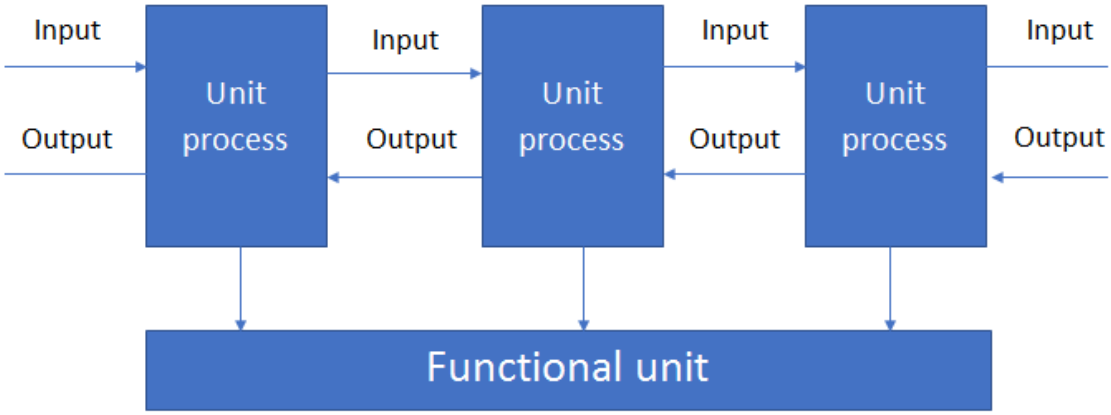

Diagram 1 - The limits of the product system, source Kulczycka 2011.

Another important concept is the functional unit, determined also by the researcher. The functional unit according to the ISO standard is the quantitative effect of the product system used as a reference unit in life cycle research. Three types of units can be distinguished. First, the simplest is physical units, such as meters, kilograms or kelvins. The second is a specific product and its function, i.e. cleaning 1,000 m3 of

sewage or a certain area in the field and the way it is used. The last, third type is a combination of units of the first type.[1]

One of the first publications that was a typical life cycle assessment, in this case the energy consumption in production systems, was the report presented by Harold Smith at the World Energy Conference in 1963. In the following years, global research was launched to forecast changes in the supply of fossil fuel resources for the coming years by estimating changes in the demand for natural resources and energy. In the United States, the REPA (Resource and Environmental Profile Analysis) model was developed, which made it possible to make comparisons of used amounts of materials, energy and waste generated based on their quantitative statement.

The proper beginnings of work on LCA relate to the establishment of a non-governmental association called SETAC (The Society of Environmental Sciences and Chemistry) in 1978. In the following years, two LCA, American and European schools were distinguished, which had a huge impact on conducting research in this subject for many years. In 2004, a branch of SETAC organization was established, operating in the countries of Central and Eastern Europe (SETAC CEE). As of today, its members are mainly representatives of science. The tasks of SETAC CEE are, inter alia, to promote and popularize LCA. The first, widely accepted technical structure (procedure) of LCA was published in 1993 in the document "A Code of Practice". The ISO International Organization for Standardization in the mid-1990s started work on the normalization of the LCA area and as a result a group of ISO 1404x standards was created. Based on them, Polish language versions of documents have been prepared. Currently, the following standards are in force in Poland[2]:

- PN-EN ISO 14040: 2009, Environmental management - Life cycle assessment - Principles and structure,

- PN-EN ISO 14044: 2009, Environmental management - Life cycle assessment - Requirements and guidelines.

These standards describe the principles and structure of the life cycle assessment (LCA) and provide the requirements and procedures necessary to assess the life cycle. Studies on the life cycle assessment are also carried out under UNEP (The United Nations

[1] https://www.google.pl/url?sa=t&rct=j&q=&esrc=s&source=web&cd=6&cad=rja&uact=8&ved=2ahUKEwiO_KqAyY7iAhXNtYsKHQgNCjUQFjAFegQIABAC&url=http%3A%2F%2Fwww.poznan.pl%2Fmim%2Fpublic%2Fwos%2Fattachments.html%3Fco%3Dshow%26instance%3D1000%26parent%3D62706%26lang%3Dpl%26id%3D143644&usg=AOvVaw0dgiTjwNLNsiGhdUHoxIYd

[2] http://www.ztch.umcs.lublin.pl/materialy/rozdzial_25.pdf

Environment Program), but the work called the Life Cycle Initiative deserves the most attention, being the result of the work of both SETAC and UNEP.

2.1.3 Spain

The ecolabel allows for affirming the positive environmental performance of a product. Therefore, these ecolabels are awarded to products with lower environmental impact accounting for their life cycle. There are three types: ecolabel type I, environmental self-declarations (type II) and environmental product declarations (III). The first ecolabels are voluntary schemes that affirm the least environmental impact of a product, the next, the manufacturer performs it with or without certification of a competent authority, and the latest are verified and they establish the environmental behaviour of the product.

In general, the ecolabels assess such aspects as: extraction and selection of raw material, production process (power consumption, water usage and consumption, emissions in the atmosphere and water, etc.), waste management or emission of hazardous substances.

The methodology to establish the Environmental Product Declaration (EDP) assumes the UNE-EN ISO 14025 (Labelling Type III: Environmental Product Declarations). In Spain, later appears the UNE-EN 15804 that establishes Product Category Rules (PCR) and allows for defining the common rules to perform a specific DAP for product families. In 2018, the UNE-CEN ISO/TS 14027:2018 standard was approved for the development of these PCRs.

It must be pointed out that, according to EU, from July 2013 the construction products must declare their environmental impact based on the ACV (LCA), such as DAP.

The environmental product declarations are related to, amongst other documents, the following:

Europe

- European initiative of Single Market for Green Products.
- *Resolution 2014/2208 (INI)* about the efficient use of resources: move towards the circular economy: “The European Parliament, (…) urges the Commission to propose, by the end of 2015, a main indicator and a set of sub-indicators about efficient use of resources, also in ecosystem services; it noted that the use of these harmonised indicators must be legally binding form 2018 and these must measure the consumption of resources, including the imports and exports a EU level, Member States and the industry, and consider all the life cycle of products and services, and has to be based on the ecological footprint methodology and measure of, at least, the land, water, materials and carbon use”.
- Environmental procurement. Handbook on Green Public Procurement.

- Regulation 305/2011 of Construction Products. For the evaluation of the sustainable use of the resources and environmental impact of construction work must use the environmental product declaration, when available.

Spain

- Royal Decree 187/2011 establishing the requirements of ecological design including coverage of all energy-related product – Article 10 "Presumption of conformity and harmonised standards": "(…) Likewise the Environmental Product Declarations (EPD) will be recognised by bodies which administer programs of these ecological labels Type III according to the standard «UNE-EN ISO 14025» provided that such Environmental Product Declaration are in compliance with the requirements of ecological design of applicable implementing measures".
- Order VIV/1744/2008, of June 9, whereby it is regulated the General Registry of the Technical Building Code (in Spanish, Código Técnico de la Edificación - CTE) – "Article 2. Organization: 2. (…) 2. In the General Registry of the CTE will be registered, according to the provisions of the Article 4 del CTE: (…) c) In Section 3, General Certification Register, certifications shall be registered that promote the improvement of the quality of the building referred in the paragraph 4.b) of the Article 4 of the CTE the following: (…) c.3 Environmental certifications of the product life cycle analysis and other environmental assessments of building".

- Decree 21/2006 – Paragraph 6.2: At least one family of products used in the construction of the building, understanding as a family the set of products destined to the same use, will have to have a Distinctive of guarantee of environmental quality of the Government of Catalonia, Ecological Label of the European Union, AENOR Environmental label, or any other type I of ecological label, according to the UNE-EN ISO 14024/2001 or type III, in accordance with the UNE 150025/2005 IN standard.

3. ENVIRONMENTAL PRODUCT DECLARATION AND ECOLABELS

The ecolabel allows for affirming the positive environmental performance of a product. Therefore, these ecolabels are awarded to products with lower environmental impact accounting for their life cycle. There are three types: ecolabel type I, environmental self-declarations (type II) and environmental product declarations (III). The first ecolabels are voluntary schemes that affirm the least environmental impact of a product, the next, the manufacturer performs it with or without certification of a competent authority, and the latest are verified and they establish the environmental behaviour of the product.

In general, the ecolabels assess such aspects as: extraction and selection of raw material, production process (power consumption, water usage and consumption, emissions in the atmosphere and water, etc.), waste management or emission of hazardous substances.

3.1 ENVIRONMENTAL DECLARATION AND ECOLABELLING IN CONSTRUCTION SECTOR

3.1.1 Romania

Romania Green Building Council has established procedures for LCA with specific focus on EPDs to be easily integrated into the environmental certification tools such as GREEN HOMES and promotes similar instruments for point recognition in the LEED or BREEAM international certification. In the case of Living Building Challenge certification system, the Materials petal is designed to encourage a successful materials economy that is non-toxic, transparent and socially equitable. The two Imperatives directly addressed by Declare are Imperative 11 – Red List and Imperative 14 –Appropriate Sourcing.

In Romania there is no accredited body to emit EPDs and all the declarations are being issued by international entities. The National Institute for Research and Development in Buildings, Urbanism and Sustainable Regional Development “URBAN INCERC”, established in 2009, is the only recognized institution to perform testing on materials and emit performance certifications.

An important issue on LCA application is the waste management of materials during the entire life cycle, mainly on resulting wastes from site construction for building or demolishing. This kind of specifications are regulated by: National Waste Management Plan, Law no. 211/2011 on waste management, Law no. 101/2006 of the sanitation service of the localities, with subsequently modifications and completions. With the same purpose, regulations are still in progress to be realised. At the same time, there are different municipal decisions that control the waste management resulted of building sector, that prevent unwanted diffuse of waste in environment.

The theme of Life Cycle Assessment (LCA), as part of the Life Cycle Thinking (LCT) approach, needs to be substantially improved at national scale, not only toward a consolidated legislation, but also on the methodologies and instruments of implementation. Currently, the Romanian authorities as well as professional associations or non-governmental organisations make efforts to adapt to international tendencies, to adopt the international regulations regarding the sustainable development.

The phenomena are at the same time encouraged by the evolution of green building certification market and companies are compelled by both demand and competition to promote greener and better products.

3.1.2 Poland

In Poland (as of March 1, 2017) there are four international multi-criteria certification schemes (in alphabetical order): BREEAM, DGNB, HQE and LEED. The fifth, the latest WELL Building Standard, focusing solely on the evaluation of the impact of a building on a human being, has the first five registrations of the project3.

LCA identifies environmental issues related to products and materials and establishes the benchmark for measurement of improvements. LCA is also more and more commonly used in new product research and development when the future marketing or cost structure of a new product must be related to the environment. LCA's growing significance is evident for more and more popular eco-labeling: environmental product declarations (EPDs). EPDs are often forced by the market demand, for example LEED (Leadership in Energy and Environmental Design) in construction. The benefit to LCA is vita: reliable, transparent data for both manufacturers and consumers, enabling better decisions how to produce and use materials and products.

3.1.3 Spain

The organisms that emit EPD with repercussion in Spain are:

- EPD System: an international organization based in Sweden. It performs EPD and PCR for all types of products. EPDs are fully accessible and it can be seen if they have been made for a particular company in a country. Although there are EPDs for construction products, it is not specific to these types of products.

  Web: http://www.environdec.com/es/

- EPD Aenor (Global EPD): Based in Spain. It performs EPD and PCR, mainly, for now, for construction products. En la actualidad dispone de un número elevado de DAP en vigor, y en continuo crecimiento. Complete EPDs are available in pdf format. Agreements with the EPD system have also been signed for Aenor's EPDs to be internationalized. The Technical Building Code (CTE) is the policy and regulatory framework that establishes the requirements that buildings in Spain must meet. The CTE has a General Registry regulated by Order VIV/1774/2008 and created to increase the transparency and public control of the instruments that facilitate the implementation of the CTE. Within this register is the General Register of Environmental Certifications of the life cycle analysis in which the first EPDs were registered in September 2015 for long steel and cement products

[3] https://g4e.pl/?gclid=EAIaIQobChMI2dSkgMiO4gIVDMKyCh132QOzEAAYASAAEgLIDPD_BwE and https://plgbc.org.pl/wp-content/uploads/2017/05/Polish-Certified-Green-Buildings-2017.pdf

sectors verified by AENOR within its GlobalEPD. In Spain, there are currently two Program Managers:

- GlobalEPD Program of the Spanish Association for Standardization and Certification (AENOR). Applicable to all industrial sectors but especially active in the construction sector. It has General Instructions complying with ISO 14025 and specific requirements for the construction sector based on EN 15804. It has issued PCR and EPD in the steel, ceramic, cement and plaster sectors, and is working in others such as mortars, bricks and tiles or furniture. It forms part of the approved European Association ECO Platform Programs and has issued Declarations of its brand.
- EPDc Program of the Sustainable Construction Agenda. Applicable to construction and centred in Catalonia.

In Spain, the tasks of elaboration of technical standards are carried out in AEN/CTN 150/SC 3 "Ecological Labelling and LCA" horizontally and in the AEN/CTN 198 "Sustainability in construction".
Web: https://www.en.aenor.com/certificacion/certificacion-de-producto/declaraciones-ambientales-de-producto/declaraciones-globalepd-en-vigor

- EPD construction: developed by ITEC and COAAT of Barcelona. Specific for construction. All EPDs are accessible in EPD format. They have also developed an EPD comparator for construction product specifiers.
  Web: http://www.csostenible.net/index.php/es/sistema_dapc

Apart from these bodies, there are other associations or entities that issue or evaluate environmental parameters related to the LCA. They are as follows:

- GBC Spain: although GBC is not a EPD certifying body, it has established procedures for EPDs to be easily integrated into the environmental certification tools of the agencies (GREEN BUILDING COUNCIL, LEED and BREEAM. Specific field of construction.
  Web: http://materiales.gbce.es/declaracion-ambiental-de-productos/

- OPENDAP: open system, where environmental assessments of constructive solutions of the CTE are established. Held by the Torroja Institute and collaborating with the $ARCO_2$ team, at present there are no open EPDs available, only the available information is the CO2 emissions emitted by the materials in the analysed phases. Specific scope of construction.
  Web: http://www.opendap.es/

- PRODUCT ENVIRONMENTAL FOOTPRINT: developed by the EU, aims to be a reference portal for European EPDs, in a similar way to ecolabel (type I labelling). Currently, no EPDs has been developed, but those that are made will be available in open. General scope, not specific to construction. On the other hand, the European Commission has included within the Single Market initiative for green products a proposal for a product environmental footprint (PEF). This methodology seeks to establish a series of rules for calculating and communicating environmental information and would be in line with the criteria of International Standard ISO 14025, framework for EPDs. Several pilot projects are currently being developed for the development of PCRs for these products. From the construction point of view, there are normative for the following products: pipes, thermal insulation, metal sheets, paints, and photovoltaic panels.

  Web: http://ec.europa.eu/environment/eussd/smgp/ef_pilots.htm#pef.

- SUSTAINABLE LIFE: Environmental footprint obtained through the PEF seal. The environmental footprint presents a global vision of the impact on the environment of a product or organization, while the carbon footprint focuses on climate change by quantifying greenhouse gas (GHG) emissions. On the other hand, the water footprint analyses and quantifies the use of water using different methodologies; While the ecological footprint is a concept developed long ago by the Global Footprint Network to indicate the surface of air, land and water ecologically productive necessary to produce resources consumed by a population or group and to assimilate their residues. The study of the environmental footprint includes and calculates the carbon footprint according to ISO 14067 or ISO 14064 and the calculation of the water footprint according to ISO 14046 of the product or organization analysed. The analysis carried out by the Foundation Sustainable Life has exclusively covered companies, so it doesn't evaluate products for now.
  Web: http://www.vidasostenible.org/sellos-de-huella/

- ECO-Platform: The main European Program Managers have formed the ECO-Platform Association, for the EPDs in the construction sector. This Association seeks to harmonize criteria to facilitate the free circulation of products in Europe, avoiding technical barriers based on environmental criteria. All EPDs recognised by this Association must comply with the European Standard EN 15804 and carry a double logo: that of the Program Manager in which the verification is carried out and that of the ECO-Platform.
  Eco Platform applies a peer auditing system to approve EPD Verification Program Administrators, from which it publishes a list of Programs that can use the ECO Platform Mark. The first Programs to be approved in this Association (in 2014) were the Spanish GlobalEPD of AENOR, the Swedish International EPD AB, the

German IBU and the Austrian Bau-EPD. The first EPDs of this Association were delivered on 16 October 2014 in Brussels. In parallel, several Program Administrators are establishing bilateral mutual recognition agreements, such as the International EPD AB, IBU and AENOR GlobalEPD.
Web: http://www.eco-platform.org/

- LEVELS: Developed as a common EU framework of core indicators for the sustainability of office and residential buildings, Level(s) provides a set of indicators and common metrics for measuring the performance of buildings along their life cycle. As well as environmental performance, which is the focus, it also enables other important related performance aspects to be assessed using indicators and tools for health and comfort, life cycle cost and potential future risks to performance. It is structured as follows:
  - 1. Macro-objectives: An overarching set of six macro-objectives for the Level(s) framework that contribute to EU and Member State policy objectives in areas such as energy, material use and waste, water and indoor air quality.
  - 2. Core Indicators: A set of 9 common indicators for measuring the performance of buildings which contribute to achieving each macro-objective.
  - 3. Life cycle tools: A set of 4 scenario tools and 1 data collection tool, together with a simplified Life Cycle Assessment (LCA) methodology, that are designed to support a more holistic analysis of the performance of buildings based on whole life cycle thinking.
  - 4. Value and risk rating: A checklist and rating system provides information on the potential positive contribution to a property valuation and the underlying reliability of performance assessments made using the Level(s) framework.

  In addition, the Level(s) framework aims to promote life cycle thinking. It guides users from an initial focus on individual aspects of building performance towards a more holistic perspective, with the aim of wider European use of Life Cycle Assessment (LCA) and Life Cycle Cost Assessment (LCCA).

  Web: https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/levels-common-eu-framework-core-sustainability-indicators-office-and-residential-buildings-0

Based on previous work by the University of Seville (González-Vallejo et al, 2014; Martínez-Rocamora et al, 2016), it can be asserted that the construction materials that

control, in the case of Spain, the environmental impacts in the construction process are: concrete, steel, ceramic, aluminium, polystyrene and PVC. These materials account for about 80% of these impacts, including CO_2 emissions. We will choose material from this group and whose EPDs are from some of the companies mentioned above.

In summary, the companies active in Spain that issue and certify EPD are: EPD system (verified by TECNALIA), EPD AENOR (own verified) and DAP construction (ITEC verifier). Between these three companies we will be around 100 EPD made and currently in force in Spain. We will now compare the main features of these certifications:

	Organism	Available	Validity	Product	Regulation applied	Phases assessed	Verifier
Product of waterproofing sheet of PVC DANOPOL	EPD system	YES (PDF)	18/05/2020	PVC	15804/14025	Cradle-gate	TECNALIA
External thermal insulation system	EPD AENOR	YES (PDF)	04/04/2022	Insulation	15804/14025	Cradle-grave	AENOR
CEMENT CEM II	EPD AENOR	YES (PDF)	30/09/2019	Cement	15804/14025	Cradle-gate	AENOR
Porcelain stoneware - Colorker	EPD construction	YES (PDF)	18/07/2021	Ceramic tile products	14025/21930	Cradle-grave	ITEC

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