THE ENVIRONMENTAL IMPACT OF A ETICS LAYER: A CASE OF STUDY WITH LIFE CYCLE ASSESSMENT (LCA) FROM ENVIRONMENTAL PRODUCT DECLARATION (EPD) IN PORTUGAL

IMPACTO AMBIENTAL DE UMA CAMADA DO SISTEMA ETICS: UM ESTUDO DE CASO DE AVALIAÇÃO DO CICLO DE VIDA (ACV) A PARTIR DA DECLARAÇÃO AMBIENTAL DO PRODUTO (DAP) EM PORTUGAL

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ABSTRACT
This paper is focused on LCA (Life Cycle Assessment) of specific product based on lime used in Portugal how a more sustainable solution for building construction. This product is decorative mineral render based on lime used as final layer to an External Thermal Insulation Composite System (ETICS) based on cork boards (ICB). The case under study presents as differentials the use of cork, a natural product that has Portugal as the largest supplier in the world and mortars with a greater amount of lime and less use of cement. This is an attempt to reduce the ecological footprint by the manufacturer. In this way, this article analyses the data provided in the Environmental Product Declaration (EPD) by the manufacturer, trying to establish a comparative impact reduction with other similar products.

KEY WORDS: LCA (Life Cicle Assessment); External Thermal Insulation Composite System (ETICS); EPD (Environmental Product Declaration)

RESUMO
Este artigo está focado na ACV (Avaliação do Ciclo de Vida) de um produto específico à base de cal utilizado em Portugal como uma solução mais sustentável para a construção civil. Este produto é um revestimento mineral decorativo à base de cal empregado como camada final em um Sistema Composto de Isolamento Térmico Externo (ETICS) constituído por placas de cortiça (ICB). O caso em estudo apresenta como diferenciais o uso da cortiça, um produto natural que tem Portugal como maior fornecedor mundial e argamassas com maior quantidade de cal e menor uso de cimento, na tentativa de reduzir a pegada ecológica do produto para o fabricante. Dessa forma, este artigo analisa os dados fornecidos pela Declaração Ambiental do Produto (DAP) do fabricante, tentando estabelecer um comparativo da redução do impacto com outros produtos de uso similar.

PALAVRAS-CHAVE: *ACV (Avaliação do Ciclo de Vida; Sistema Compósito de Isolamento Térmico Externo (ETICS); DAP (Declaração Ambiental de Produto)*

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1. INTRODUCTION

Many things affect the quality of the life on Earth. Due to that, scientists and engineers are working on improving the quality of life by innovating new technologies and implementing new methods for the industries that are decreasing the life quality. Nowadays, it is important to be sustainable, due to climate crisis and many environmental issues.

The sustainable building must be efficient in the management of water, waste and energy, among many other things. For the building to be energy efficient, it must have good insulation systems in order to reduce energy consumption. One of the most important elements, in this point of view, is the building's façades, where 70% of the term changes occur in buildings with more than three floors. In European countries, like Portugal, the importance of ensuring good thermal insulation for the facades is even greater, as the thermal variations can range from 30 °C until -10 ° C.

However, the sustainability of the insulation system is not only in its contribution to energy expenditure in the building use stage, but also in reducing the impacts on its production of its components during the initial stages of the life cycle.

Life Cycle Assessment (LCA) is the tool by which a product’s impact on the environment through its lifetime is evaluated. In the context of recycling, it helps to determine if waste reduction, recycle, resource recovery or disposal is the best practicable environmental option. It has been extensively applied in solid waste management (MCDonough and Braungart, 2010), but also is applied in assessment of others impacts, like energy consume, water and GEE – Greenhouse Gases Emissions.

Life Cycle Assessment (LCA) methodologies were developed to create decision support tools for distinguishing between products, product systems, or services on environmental grounds. The evolution of the methodology brings a number of related applications like its use as basis to communicate the environmental performance of the products to stakeholders. (DEL BORGHI, 2013). This communication of the environmental impacts of the products can be accomplished through environmental declarations made by the manufacturers.

There are specifics standards for LCA-based environmental labels and declarations (ISO 14021 (1999), ISO 14024 (2006), and ISO 14025 (2009). According to Del Borghi (2013) an Environmental Product Declaration (EPD), is a type III of environmental declaration standardized by ISO 14025 (2009) and LCA-based tool to communicate the environmental performance of a product. The EPD must meet a number of requirements for how the LCA should be performed to be used as basis for an EPD.

This paper is concentrated on LCA of specific alternative product based on lime. This product is decorative mineral render based on lime used as final layer to an External Thermal Insulation Composite System (ETICS) based on corkboards. The Figure 1 shows a generic ETICS system and its components available in Portuguese market. ETICS are often used in Europe since the 70’s, both in new buildings and in retrofitting (BARREIRA; FREITAS, 2014).

In other countries, such as the United States and Canada, ETICS is known by other names, such as EIFS (External Insulation and Finishing System), also called External Wall Insulation Systems in Ireland and the United Kingdom, and in the case of Spain it is known as SATE (Sistema de Aislamiento Térmico Exterior) (PERDIGÃ0, 2013). In Portugal, it is commonly referred as CAPOTO.

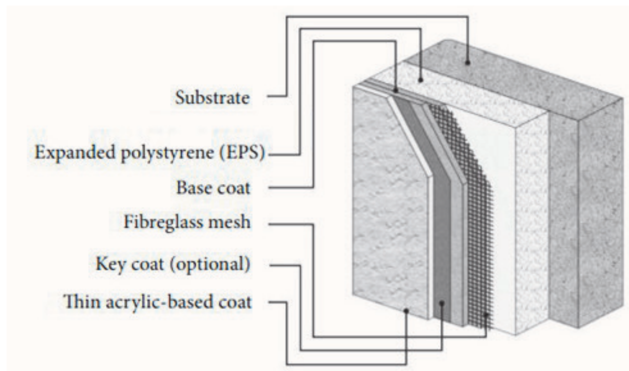

Figure 1 - Schematic example of ETICS available in the Portuguese market.
Source: BARREIRA; FREITAS (2014), FREITAS (2002).

Perdigão (2013) realized a comparison of the environmental impact of two ETICS systems of the same composition in the layers, with modification only of the insulation layer: one with EPS board (Expanded Polystyrene) and the other with ICB (Insulation Coark Board). A summary of the comparison made regarding the main environmental impacts is presented in table 1, highlighting in green for the system that has less impact in the evaluated categories.

	System A		**System B**	
	Characterization	Normalization	Characterization	Normalization
Embodied energy (MJ/m2)	257,3117		79,037	
Global warming (kg CO2 eq)	27,14077	0,002212	25,7015	0,002095
Ozone depletion (kg CFC-11 eq)	4,1E-06	1,37E-05	4,06E-06	1,35E-05
Photochemical oxidation (kg C2H4 eq)	0,031765	0,000986	0,023891	0,000742

Acidification (Kg SO2 eq)	0,131233	0,002228	0,132384	0,002248
Eutrophication (kg PO4 3- eq)	0,04953	0,006191	0,051671	0,006459
Primary energy (MJ eq)	530,1171	0,003475	473,0208	0,003101

Table 1 - Comparative summary ETICS with EPS (system A) versus ICB (system B) in the characterization and normalization steps.
Source: PERDIGÃO (2013).

Table 1 shows the lower environmental impact of the ETICS composed of cork boards. However, some characteristics such as the finishing layers may suffer alterations, which justifies this research.

2. MATERIALS AND METHOD

2.1. About ETICS

An External Thermal Insulation Composite System (ETICS), as its name indicates, is a system in which insulation is applied from the outside of the building. According to Collina (2007) ETICS is a "system usually including an adhesive, a leveling mortar, an insulation panel, an alkali-resistant reinforcement grid, a primer and a finishing coat, as well as sealants and accessory materials for the installation." Its benefices are:

> "guarantees the reduction of the thermal bridges and greater thermal comfort due to the higher interior thermal inertia, providing a finished appearance similar to the traditional rendering. From the construction point of view, ETICS allows thinner exterior walls and increases the facades' durability. To the pointed advantages, three very relevant aspects in the construction industry must be added: low cost, ease of application, and possibility to be installed without disturbing the building's dwellers, which is particularly important in refurbishment." (BARRREIRA; FREITAS, 2014)

However, ETICS practical applications, normally in Portugal with EPS (Expanded Polystyrene) boards, showed some problems: (i) low impact resistance; (ii) cladding defacement due to biological growth; (iii) lack of flatness; (iv) cracks along the insulation board joints or windows corners; (v) accumulated dirt; (vi) blistering or delamination of the finishing coating or of all rendering layers; and (vii) lack of adhesiveness of the system. The scientific community has performed studies to characterise these systems: properties of its components, main problems, and, to develop solutions (BARRREIRA; FREITAS, 2014; KÜNZEL et. al., 2006).

Other authors, such as Michałowski et. al. (2020), have analyzed the behavior of the external layers of ETICS systems. This research assumes special relevance for this paper.

The Figure 2 shows ETICS system used on this research and its components. The case under study presents as differentials the use of cork in boards and mortars. Cork is a natural product that has Portugal as the largest supplier in the world. The focus of this research is the layer 9 that use a mortar with a greater amount of lime and less use of cement, in an attempt to reduce the ecological footprint by the manufacturer. In this way, this article analyzes the data provided in the Environmental Product Declaration by the manufacturer, trying to establish a comparative impact reduction with other products. (UNOPS, 2009; MATOS et. al., 2020)

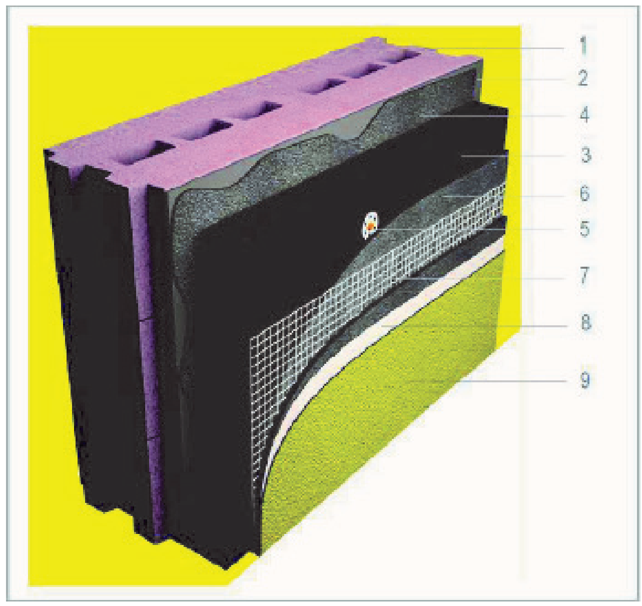

Figure 2 - Composition of insulating coating for exterior (ETICs).
Source: Weber Naturcork (2020).

1) Base (wall)
2) Regularization mortar layer. Mortar adhesive naturcork
3) Insulation board: thermo cork
4) Mortar adhesive with cork
5) Mechanical fixings
6) Mortar coating (2 layers): Weber. Therm naturcork.
7) Fibber mesh cloth
8) Finishing: natural skim. Naturkal

The scope of the analysis is restricted to the production of the lime mortar for the ETICS system finishing layer. Soon the production stages analyzed comprise A1 (Raw Material Extraction and Processing), A2 (Raw

Material Transportation for Lime Production), A3 (Lime Mortar Production). Stages A4 (Transport of the Product to the building site) and A5 (Construction and Installation Process) was not considered. For this research, the data provided by the manufacturer from A1 to A3 are analysed from cradle-to-gate method.

It is very difficult for suppliers to report the data for the A4 and A5 steps, because the construction site distance differs and consequently transport distances change and construction processes (A5) also need the support of builders to be obtained. When the supplier enters these data into the EPD, it is because he has carried out some case study on a specific site. Thus, these studies are generally unrepresentative.

2.2. Case of study

The product analised on this research is a mineral lime based colored finishing product for interior and exterior walls. It is composed of aerial lime, cement, aggregates and organic and/or inorganic specific additives. Table 2 shows the components for finishing layer on ETICS and its technical characteristics (figure 1, layer 9).

Component	Percentage (mass)
Hydrated lime	15%
Cement	6,5%
Inert material	73,5%
Additives	5%

CE mark: EN 998-1:2010	Testing / Decision	Declared value	Units
Density	EN 1015-10	]1000-1200]	kg/m³
Adherence	EN 1015-12	≥ 0,30	N/mm²
Thermal conductivity	EN 1745 Tabulated value; P=50%	(λ10,dry) 0,33	W/m.K
Water absorption	EN 1015-18	W1	---
Permeability to water vapor	EN 1015-19	< 15	---
Class of reaction to fire	Comission decision 2000/147/CE	Class F	---

Table 2 - Composition of layer 9 (for finishing) and technical characteristics of lime mortar for ETICS system.
Source: Weber Naturkal (2020).

2.3. Procedure

This article analyses the data provided in the Environmental Product Declaration (EPD) by the manufacturer, trying to establish a comparative impact reduction with other products based on cement. The environmental impact was analysed only for one layer of ETCIS: the finishing layer considering de fabrication process for Carregado, an unit for Saint Gobain Factory in Portugal.

The EPD was analysed. The scope used for ACV is known as the "cradle to gate " and the following life cycle stages have been considered: raw materials supply (A1); transport (A2) and manufacturing (A3) (WEBER, 2020).

The impact indicators analysed was:

Global Warming Potential (GWP) is mostly affected by emission of global warming gases produced while burning fossil fuels to produce thermal energy or electricity, for instance;

Depletion Potential of the Stratospheric Ozone Layer (ODP) - Ozone layer depletion is caused by different substances, where the most relevant are fluorinechlorine- hydrocarbons (CFC's) and nitrogen oxides;

Acidification Potential of land and water (AP) has very damaging effects on ecosystems and is caused by transformation of air pollutants into acids;

Eutrophication Potential (EP) - Eutrophication is caused by anthropogenic emissions, pollutants in wastewater and fertilization of soils. It results in an increased concentration of nutrients, causing various damages to the ecosystems. Phosphate, nitrites and ammonia are the main pollutants that contribute to this effect;

Photochemical Ozone Creation Potential (POCP) - Production of ozone at ground-level (troposphere) is harmful for ecosystems and humans. It is caused by the chemical reaction between nitrogen oxides with hydrocarbons (VOCs), producing different pollutants, including ozone. Most of the tropospheric ozone is created from the reactions between substances emitted from vehicles, industrial plants and vegetation;

Potential for abiotic depletion of resources – elements for non-fossil resources (ADPE) - This category characterizes the depletion of non-energetic resources, reflecting the shortage of these materials in the geosphere; e,

Potential for abiotic depletion of resources – fossil fuels (ADPF) - This category characterizes the depletion of fossil fuels used in the production process.

2.4 Comparative

Some materials have been chosen that can replace the focus finish coat of this research as a way of establishing a comparison. The data of the mortars used for comparison were extracted from the research of and Toledo Filho (2018), keeping the same thickness of the layer (0.5 centimeters). These products are:

- Single mortar 1 (ciment) :3 (sand) (volume); single mortar 1 (ciment) :5 (sand) (volume); mortar 1 (ciment):2 (hydrated lime) :9 (sand) (volume) for single layer; mortar 1 (ciment): 3 (hydrated lime) :12 (sand) (volum) for a single layer.

3. LITERATURE REVIEW

3.1 Life Cycle Analysis (LCA)

Life Cycle Analysis (LCA) is a method used to evaluate the environmental impact of a product through its life cycle encompassing extraction and processing of the raw materials, manufacturing, distribution, use, recycling, and final disposal.

As written by Ok et al. (2018)

> “life cycle analysis can be dated back to the 1960s when worldwide concerns on the rapid depletion of limited raw materials and energy resources sparked interest in finding ways to understand and forecast the supply and utilization of energy and resources in the future. During the 1970s, the energy crisis caused by the oil shortage prompted a critical review of the energy-intensive nature of process industries. This motivated the need for a system-oriented tool, such as LCA, to track materials and energy flows in industrial systems.”

The concept of Life Cycle Analysis is used for the analysis stage of life cycle assessment. The most important component of LCA is goal definition (ISO 14040), and the inventory analysis can be qualitative and/or quantitative, it is an analysis of the resources used and the emissions generated in the life cycle.

Approximately 5% of global carbon emissions are produced in the manufacture of cement. Engineers and scientists are working on reducing that percentage, by exploring new techniques and materials that can be used instead of cement powder in concrete or mortar production. The resulting by products of cement production have a large effect on the environment because cement production requires large quantities of raw materials and energy.

3.2 LCA on ETICS

Michałowski et. al. (2020) compared the environmental impact allocated to the 1 m2 of the produced system by taking into account the thickness of EPS (10, 15 and 20 cm) and within different environmental impact categories on ETICS for 4 renderings types: MR (Mineral Render), AR (Acrylic Render), SR (Silicon Render) and Si-SIR (Silicon-Silicate Render). The authors considered the consumptions of the table 3 for this research.

Category	Component Description	Quantity per m2
Adhesives for bonding the EPS	Cement-based adhesives modified with redispersible polymers, fibers, and mineral fillers	4.5 kg
Insulation	Prefabricated EPS board	1.35 kg
Adhesive for base coat	Cement-based adhesives modified with redispersible polymers, fibers, and mineral fillers	≥ 0.15 kg
Glass fiber meshes	Alkaline-resistant glass mesh with a nominal weight of 150 or 165 g/cm2	ca. 0.2 kg
Key coats	Acrylic key coat with quartz filler Mineral key coat with mineral/quartz filler	2.0–4.5 kg
Finishing coats	Mineral render	0.1 kg
	Acrylic render	
	Silicone render	
	Silicone-silicate render	
Primers (optional)	Silicate (potassium water glass) primer	0.2 kg
	Silicone-silicate primer	
Decorative coats (optional)	Silicate mineral-based paint	-
	Acrylic-based paint	
	Silicone-based paint	
Ancillary materials	Anchors, special fittings	

Table 3 – ETICS system components as described in the National Technical for buildings in Polony (ITB AT-15-9090/2016).
Source: Michałowski et. al. (2020).

Michalowski et al showed “that the main influences of ETICS systems on the environment were neither the production process of system components, nor the internal transport at the manufacturing site, but the choice of raw materials used to produce system components, and suitable system components themselves”.

In the comparison between the four types of plasters, through the survey, the authors found the lowest environmental impact for the MR layer in the GWP, AP, EP, POCP, ADPF, categories, except in category ODP and ADP the where SR and AR had equal or lower results for 1 m2.

3.3 Application in construction

The lime mortar is used as finishing layer to a ETICS system based on cork boards. The layer is applied as finishing colored mineral lime based for interior and exterior walls. It is composited of hydraulic lime, hydraulic binder, fillers selected, synthetic fibers and specific adjuvants.

The ETICS system mentioned is exterior termal insulating system to install in building facade walls, incorporating insulating boards of natural origin, with high contribution to environmental sustainability. Also, functional rehabilitation (waterproofing, cracking and aestetics) and improved thermal insulation of facades in buildings with existing type system incorporating ETICS insulating boards of natural origin. It allows the realisation of work entirely outdoors, without interference with the use of interior spaces.

The product also requires the addition of water and the use of a mixer to blend the water and the powder. The information on the data sheets regarding consumption of water in this product is showed on table 4.

Product used	Quantity per m² of system	Unit
Weber .rev naturkal	3	kg/m² of wall
Water	8	L/bag

Input	Data set used	Quantity per m² of system
Water	Tap water, at user/RER U	0,96 L = 0,96 kg

Table 4 - Information on technical data sheet - water consumption.
Source: Weber; Centro Habitat Portugal (2020).

Considering that each bag has 25 kg of product, the amount of water used at this stage is 0,96 L/m2.

4. DATA COLLECTION

4.1 Production of based lime mortar for finishing

As seen in table 2, this finishing mortar consists of cement, lime, inert materials and additives. The detailed composition is showed on table 5.

When arriving at the factory, the cement is placed in storage silos. When the production order is received, the materials are weighted on scales and sent to a mixer, where all the elements are blended. The final product is then discharged into bags. The bags are then placed on wood pallets and wrapped with plastic film.

The raw materials are received in tankers, bags or big-bags. The final powder product is obtained from the mixture of different components, following a pre-established formulation. The weighing of the different components is performed within one of the three weighing hoppers. Once dosed the components are discharged into the empty blender through pneumatic valves for homogenisation. The figure 3 present the entire process for production the lime mortar for finishing.

The raw materials and pre-products used in weber.rev naturkal product are shown in the Table 5.

Product	Raw materials / pre-products	Quantity per ton of product	Unit	Quantity per kg of product
weber. rev naturkal	White cement	6,50E+01	kg	6,50E-02
	Lime	1,50E+02	kg	1,50E-01
	Calcium carbonate	6,98E+02	kg	6,98E-01
	Calcium carbonate < 100mm	3,00E+01	kg	3,00E-02
	Cellulose ether	2,00E+00	kg	2,00E-03
	Starch Ether	1,00E+00	kg	1,00E-03
	Polymer	3,00E+01	kg	3,00E-02
	Polyacrylonitrile fibers	1,00E+00	kg	1,00E-03
	Superplasticizer	1,00E+00	kg	1,00E-03
	zinc stearate	5,00E+00	kg	5,00E-03
	Sodium oleate	2,00E+00	kg	2,00E-03
	Perlite	1,50E+01	kg	1,50E-02
	Biocide / Algaecide	2,50E-01	kg	2,50E-04

Table 5 - Materials used in production process of mortar powder in Carregado Industrial Plant / Portugal.
Source: Weber; Centro Habitat Portugal (2020).

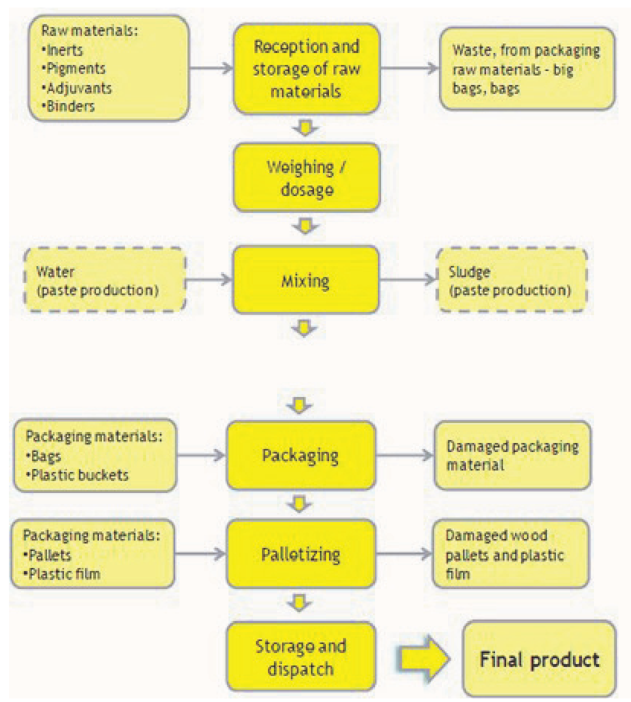

Figure 3 - Production Process
Source: Weber; Centro Habitat Portugal (2020).

4.2 Impacts from EPD (Environmental Product Declaration)

The table 6 presents the resume for inputs and outputs per ETICS with CIB. The consumption of the finishing coat made of lime mortar is highlighted in red in table 6.

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System	Material	Module	Quantity per m² of system	Units
Weber. therm natura l	Alluminium profile	A5	1,94E-01	kg
	Metallic screws with plstic dowels	A5	4	units

Weber. therm natura l	Plastic screws	A5	8	units
	Electritciity (drill)	A5	4,72E-03	kWh
	Weber.therm naturcork	A1-A3	6	kg
	Water (mixing)	A5	1,68	kg
	Electricity (low voltage)	A5	7,00E-03	kWh
	Insulation board of ICB	A1-A3	40 mm * 1m² * 110kg/m³ = 4,40E+00	kg
	Electricity (low voltage)	A5	5,67E-03	kWh
	Fiber glass mesh	A5	160 gm² * 1m² = 0,16	kg
	Weber.therm naturcork	A1-A3	5	kg
	Water (mixing)	A5	1,2	kg
	Electricity (low voltage)	A5	5,83E-03	kWh
	Weber.rev naturkal	A1-A3	3	kg
	Water (mixing)	A5	0,96	kg
	Electricity (low voltage)	A5	3,53E-03	kWh

Table 6 - Inputs and outputs of ETICS Weber.therm natura l.
Source: Weber; Centro Habitat Portugal (2020).

4.3. Module A1-A3 – Lime Mortar production

The indicator "Use of renewable primary energy resources used as raw materials" should consider the amount of energy resources used as raw materials to be incorporated in the product or in packaging. It was considered the amount of incorporated energy in wood products and paper in the products manufactured.

Product	Raw materials / pre-products	Quantity per ton of product	Unit	Quantity per kg of product
weber. therm pro	wood pallet	7,10E-01	unit	7,10E-04
	Bag (kraft, paper and film)	4,00E+00	kg	4,00E-03
weber. therm naturcork	wood pallet	7,10E-01	unit	7,10E-04
	Bag (kraft, paper and film)	4,00E+00	kg	4,00E-03
weber.rev naturkal	wood pallet	9,50E-01	unit	9,50E-04
	Bag (kraft, paper and film)	4,00E+00	kg	4,00E+03

Table 7 - Renewable resources used in mortar powder products.
Source: Weber; Centro Habitat Portugal (2020).

At the graph of the figure 4, the potential impact associated to production of the main components is shown, including, the impacts of lime mortar (green color).

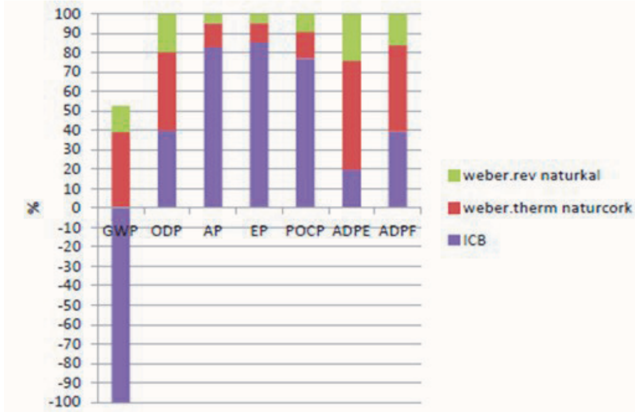

Figure 4 - Comparative Impact characterisation of system components with relation of lime mortar (green color).
Source: Weber; Centro Habitat Portugal (2020).

The system indicated at red color has a global positive impact in the category of GWP. This occurs due to the use of cork that contributes to fixation of carbon dioxide during photosynthesis. The negative impacts are associated to the use of the mortar products. Production of clinker and hydraulic lime are the processes that represent the most significant impacts in this category, due to the emission of pollutants during combustion of fossil fuels to produce energy.

The main responsible for the impacts in ODP category are the mortar with coark and ciment and hydraulic lime (red color) followed by ICB. In this case, the main processes responsible for the impacts are the combustion of heavy fuel oil during production of hydraulic lime and crude oil in production of propane. The impacts of these products result from emission of organic halides and CFC during the combustion of these fossil fuels.

Depletion of abiotic resources – elements category is mostly influenced by mortars. Impacts associated with these products are due to the use of polymer and cellulose ether. The production of the polymer is associated to extraction of zinc.

Impacts on the category ADPF are associated to mortar with ciment, followed by ICB and the lime mortar (green color). The impacts are associated to extraction of fossil fuels to produce energy.

Regarding the ETICS, the insulation material (ICB) is the one with the greatest impacts in most of the categories. In ODP and ADPF categories it has almost the same percentage of impacts as weber.therm naturcork and the fiber glass mesh, while in ADPE it has a low impact (<5%).

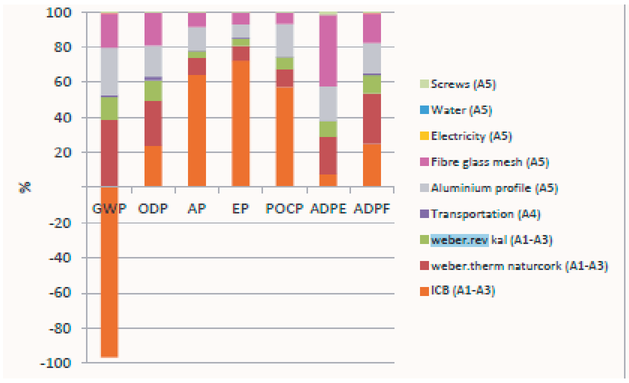

Figure 5 - Comparative of Impact characterisation of mortar lime (green color) with another components of the ETICS.
Source: Weber; Centro Habitat Portugal (2020).

The table 8 shows the quantitative impacts for lime mortar (finish layer of the ETICS) versus mortars with ciment (1:3; 1:5; 1:2:9 and 1:3;12). The least impact was highlighted with the color green. It can be observed that the finishing layer using lime mortar, as less cement incorporated is the one with the lowest impact in almost all categories, considering the same thickness of coating (with consumption of 0.05m3/m2).

	Mortar lime	Mortar 1:3	Mortar 1:5	Mortar 1:2:9	Mortar 1:3:12
GWP - Global warming potential (kg CO2 eq)	2,88 E^{-1}	1,87E+01	1,33E+01	1,79E+01	1,71E+01
ODP - Ozone layer depletion potential (kg CFC-11 eq)	2,77 E^{-8}	1,23E-06	9,45E-07	1,32E-06	1,29E-06
Photochemical ozone creation potential (POCP) (kg C2H4 eq)	8,51 E^{-5}	2,72E-03	1,98E-03	3,20E-03	3,17E-03
AP - Acidification potential (Kg SO2 eq)	1,03 E^{-3}	4,44E-02	3,35E-02	3,89E-02	3,68E-02
EP - Eutrophication potential (kg (PO4) 3- eq)	6,43 E^{-4}	6,25E-03	4,90E-03	5,55E-03	5,30E-03
Abiotic depletion potential for non - fossil resources (kg Sb eq) ADP e	7,83E^{-7}	1,36E-06	9,65E-07	9,55E-07	8,70E-07
Abiotic depletion potential for fossil resource (MJ P.C.I) ADPff	4,28	1,16E+02	8,70E+01	1,15E+02	1,11E+02

Table 8 - Comparative of impacts. Source: Weber; Centro Habitat Portugal (2020); Caldas; Toledo Filho (2018).

5. CONCLUSION

On the unit of 1kg of product in powder, the tests were made, considering its applications conditions in ETICS. In this case, it was considered the product with the worst case scenario in according with supplier information. The raw materials are received in the industrial units in tankers, plastic bags or big-bags. Storing bulk materials in silos can be made directly or through a pneumatic conveying system. The final powder product is obtained from the mixture of different components, following a pre-established formulation. The dosage of the raw materials can be carried out by a worm screw with frequency controller and volumetric dosage through a rotary valve. The weighing of the different components is performed within one of the three weighing hoppers.

Once dosed the components are discharged into the empty blender through pneumatic valves for homogenization. The mixing time varies depending on the specific composition of the product. After this, the product falls into the hopper of the blender and is then discharged.

The last stage consists in packing and palletizing the product. Regarding powder products, they are packed in printed kraft paper bags (coated on the inside with PE film) through electric equipment and then placed on a pallet. At last, the pallet and bags are wrapped in a plastic film and covered with a plastic bag. The packed product is transported by forklift and stored until dispatch.

In this research, it was observed that the data provided in the manufacturer's EPD for the product can provide a good source for consultation and allow comparison of impacts throughout its life cycle. The research highlighted the lower impact of ETICS composed of cork panels. Furthermore, considering the final finishing layer, it was possible to obtain the environmental impacts and prove the good environmental performance of the products in the aspects analysed as compared to other finishing possibilities made up of mortars with a greater amount of cement.

Finally, it can be stated that the EPDs made available by manufacturers can become important tools for choosing materials and components in building design.

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