SECTOR ENVIRONMENTAL PRODUCT DECLARATION: CERAMIC TILES

Teresa Ros-Dosdá[1], Clara Giner[1], Gerard Balaguer[1], Irina Celades[1], Victoria Zaera[2], Alejandra Miralles[2]

[1]Instituto de Tecnología Cerámica (ITC)- AICE - Universidad Jaume I, Campus Universitario Riu Sec, Av. Vicent Sos Baynat s/n, 12006 Castelló, Spain

[2] Spanish Ceramic Tile Manufacturers' Association (ASCER), Rda. Circunvalación, 186, 12003 Castelló de la Plana, Castelló, Spain

ABSTRACT

The construction industry provides major economic and social contributions, but its exponential growth also makes it one of the sectors with the highest rates of energy and resource consumption and waste generation. Currently, increased environmental consciousness among end consumers, government authorities and business enterprises has led to an increase in the supply and demand of products and services that are more respectful of the environment. In addition, in view of the climate emergency facing the planet, governments around the world are intensifying their efforts to reduce carbon emissions through laws, regulations, directives and action plans.

As a result, demand for trustworthy environmental information on products and services is increasing. In particular, in the case of the construction industry, the deployment of Environmental Product Declarations (EPDs) is gaining momentum.

Understanding the magnitude and nature of such impacts is essential to being able to focus mitigation efforts and improve product sustainability compared to other emerging products and competing materials.

In this sense, since 1992, ITC-AICE, ASCER and companies in the sector have been working together to compile environmental information by setting benchmarks, assessing the information via Life Cycle Assessment (LCA), and notifying the results to third parties in a standardised manner using Environmental Product Declarations (EPDs). Currently, 80+ individual EPDs have been verified and commissioned by more than 25 companies in Spain's ceramic industry. In addition, in 2019, the first version of the sector EPD for ceramic tiles was verified and published at national level.

This paper discusses the methodology used to run these LCAs and the renewal of the Spanish ceramic tile industry's EPD within the GlobalEPD and the INIES programmes (a document equivalent to an EPD is referred to in the latter, in French, as an FDES (*Fiche de Données Environnementales et Sanitaires*). The most relevant results will be presented at QUALICER, along with the conclusions drawn from its analysis and comparison with other industry studies.

1. CONTEXTUALIZATION

The current increase in environmental awareness by end consumers, government bodies and business enterprises has led to an increase in the supply and demand of more environmentally friendly products and services. Furthermore, in view of the climate emergency facing the world, European and American governments and institutions are imposing legislative restrictions to intensify efforts to reduce carbon emissions through laws, regulations, directives and action plans.

This has led to increased demand for environmental information about products and services. In particular, in the case of the construction industry, the use of Environmental Product Declarations (EPDs) is gaining momentum. "At the beginning of January 2023, more than 16,000 EPDs verified according to EN 15804 for construction products had been registered worldwide. With almost 90,000 EPDs verified according to ISO 21930 and more than 25,000 EPD according to EN 15804, it is likely that approximately 130,000 EPD exist for construction products worldwide" [1].

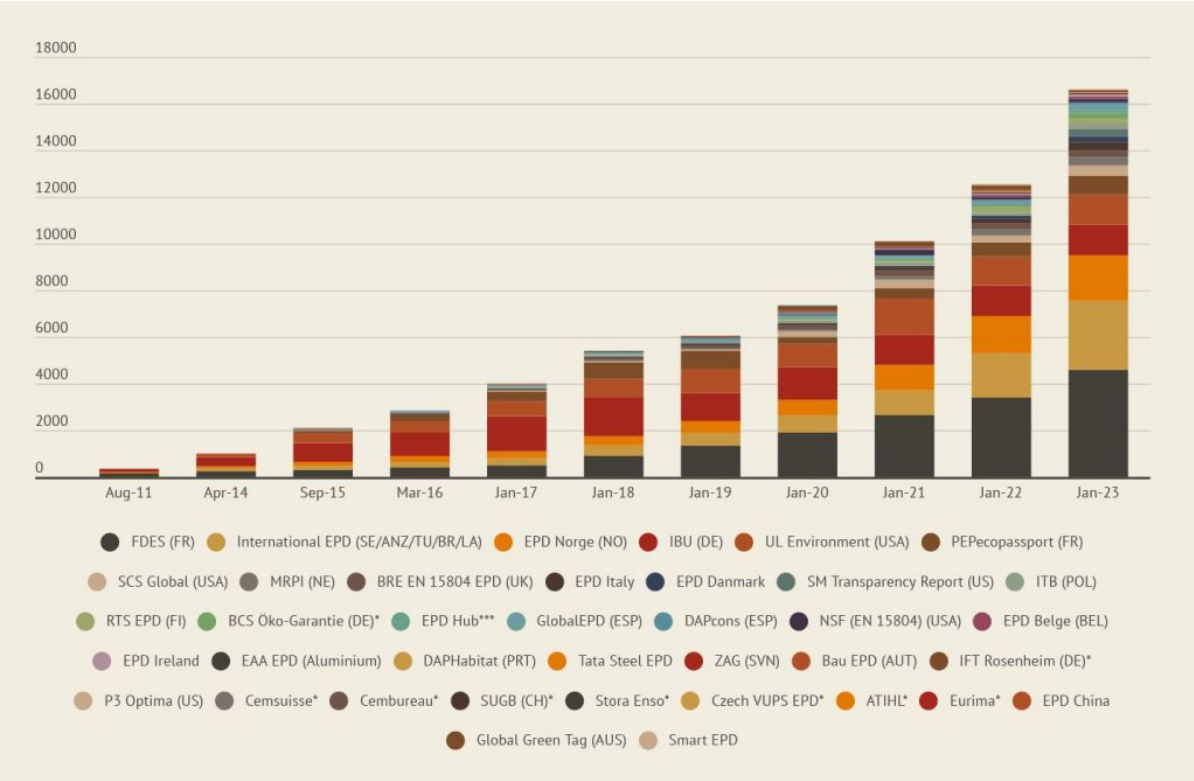

Figure 1. EPD conforming to EN 15804 registered as at early 2023 (information prior to 2019 not collected). [1]

EPDs provide standardised information on the environmental impacts of products throughout their life cycle, calculated by means of a Life Cycle Assessment (LCA).

LCA studies make it possible to objectively identify, classify and quantify the effects that any product has on the environment throughout its life cycle, compiling an inventory of the system's relevant inputs and outputs, assessing the potential impacts associated with those inputs and outputs, and interpreting the results of the inventory and impact phases in relation to the objectives of the study, as laid down in UNE EN ISO standards 14040 and 14044.

An EPD (Environmental Product Declaration) and an FDES (*Fiche de Données Environnementales et Sanitaires*, a document equivalent to an EPD when registered in the French programme) are voluntary communication tools, standardised by ISO 14025, containing the results of the environmental impacts of a product (or service) throughout its life cycle. These environmental impacts must be calculated by means of an LCA under ISO standard 14040 and in accordance with a set of common criteria defined in *Product Category Rules* (PCRs). EPDs can be verified by an independent third party, within the framework of a *Programme Manager* that meets the requirements set forth in the reference standards.

In the case of ceramic tiles, the specific applicable PCRs are EN 15804+A2 (core rules for the product category of construction products), EN 17160, specific rules for ceramic tiles and specific rules for EPD operator programmes.

The impact categories and flow indicators for ceramic tiles are those recommended by UNE EN standard 15804:2012+A2:2019, included in the Environmental Footprint method.

It should be noted that the results produced are relative expressions and do not predict impacts in endpoint categories or excesses of certain levels, safety margins or risks.

Today, EPDs have become a common tool for understanding and assessing the environmental impacts of a material or product. According to recent publications, they are widely used to help designers and architects make decisions, create more environmentally friendly designs and meet specific environmental goals.

Currently, there are 38 EPD operator programmes, as shown in Figure 1. The Top 5 programmes in construction materials are: FDES (France), The InternaltionalEPD (Sweden), EPD Norge (Norway), IBU (Germany) and UL Environment (USA), which account for over 75% of all published EPDs (see Figure 2).

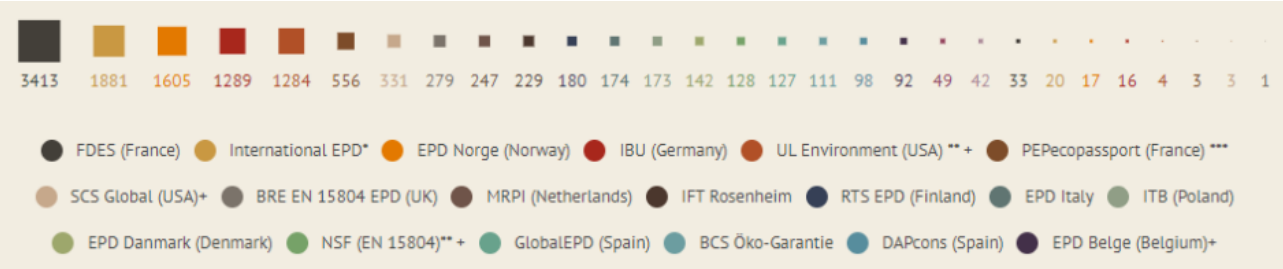

***Figure 2**. Number of published construction product EPDs [1]*

RECOGNITION OF ENVIRONMENTAL PRODUCT DECLARATIONS

At European level, the Construction Products Regulation 305/2011 cites the priority use of environmental product declarations to communicate sustainability-related aspects of a product.

The Regulation, which is currently under revision [9], is evolving to facilitate the ecological transition and digitalisation of product information, fostering the exchange of harmonised data, improving traceability and transparency between the different stakeholders in the value chain [9], enabling a level playing field and supplementing the information provided in product manuals and labels. In this sense, explicit references are included to Smart CE (digital CE marking) and the Digital Product Passport (digitalised information system to record, process and share product-related information between companies in the supply chain, authorities and consumers, information that is relevant to product circularity and sustainability). As far as environmental information is specifically concerned, the intention is for the Digital Product Passport to contain digitalised environmental information from EPDs and be compatible with private initiatives such as Building Information Modelling (BIM), a clear indication of the relevance that EPDs are gaining. Other legal initiatives related to promoting the use of EPDs at national level are described below:

In January 2022, France, the top European destination for Spanish ceramic tiles and the number two destination worldwide after the USA [13], implemented environmental regulation RE2020 [17] of the Ministry of Ecological Transition that directly affects both individual and collective homes and newly constructed office and educational buildings. The main novelty is the inclusion of greenhouse gas emissions derived from the life cycle assessment (LCA) of the building, instead of a thermal assessment only, calculated from the environmental data of the materials, products and components provided through EPDs registered as a priority in the French INIES database ([17] [14]), known in France as an FDES, *Fiche de Données Environnementales et Sanitaires*.

In the United States, the State of California passed the "Buy Clean" Bill [4], which requires EPDs for certain building materials purchased in public projects from 2022 onwards. In Denmark, the Technical Building Code imposes restrictions at legislative level to intensify efforts to reduce carbon emissions, which has greatly increased the demand for EPDs. In the UK, Germany, the Netherlands, etc., public procurement and private organisations are increasingly requesting construction product EPDs [6].

In Spain, EPDs are recognised in several national and regional regulations. Some well-known examples are Catalonia's Eco-efficiency Decree 21/2006, or the financial aid programme for renovation, refurnishing and urban actions of the Valencia Region. At national level, the General Register of the Technical Building Code allows the inclusion of environmental certifications, and so far, the EPDs of long products of steel and cements have been included.

In regard to ongoing development of standards, ISO 22057 contains the templates for the use of EPD data in modelling buildings with BIM, which will allow for the rapid digitalisation of the life cycle assessment of buildings; in addition, the standard contains an annex with the format for digital CE marking (*Smart CE*)*[2]*.

At Spanish level, the Spanish Association for Standardisation has already published several standards for Smart CE marking of specific product families [2], such as cement (UNE 80000), structural steel (UNE 36916-1), aggregates (UNE 146316-1), and natural stone (UNE 22988).

Other European initiatives, such as Level(s)*, European framework for sustainable buildings [7]*, provide a common language for assessing and reporting on the sustainable performance of buildings, from the design stage to the end of their useful life. Level(s) states that the best source of data on the environmental impact of building materials or components is the Environmental Product Declaration (EPD).

Finally, sustainable building certificates, such as LEED (USA), BREEAM (UK) or Verde (ES), recognise EPDs as valid for demonstrating the environmental performance of products and providing data for the life cycle assessment (LCA) of buildings required by those certificates.

2. CERAMIC TILE SECTOR EPD

2.1. GENERAL

The province of Castellon is home to more than 80% of ceramic tile manufacturing plants and approximately 94% of total national production in Spain. Figure 3 shows how Spanish production has evolved in the last 45 years.

Ceramic tile companies have been in constant evolution over the years to adapt to new legislation and face fresh challenges. Recently, the main challenges have been to tackle the increase in energy costs, both electricity and natural gas, and to source new raw materials as a result of the armed conflict between Ukraine and Russia.

In the last few years, ITC-AICE has been collaborating with ASCER, undertaking sector-wide benchmarking studies focused on environmental issues, Life Cycle Assessment and Environmental Product Declarations since 1992 [5] (see Figure 3).

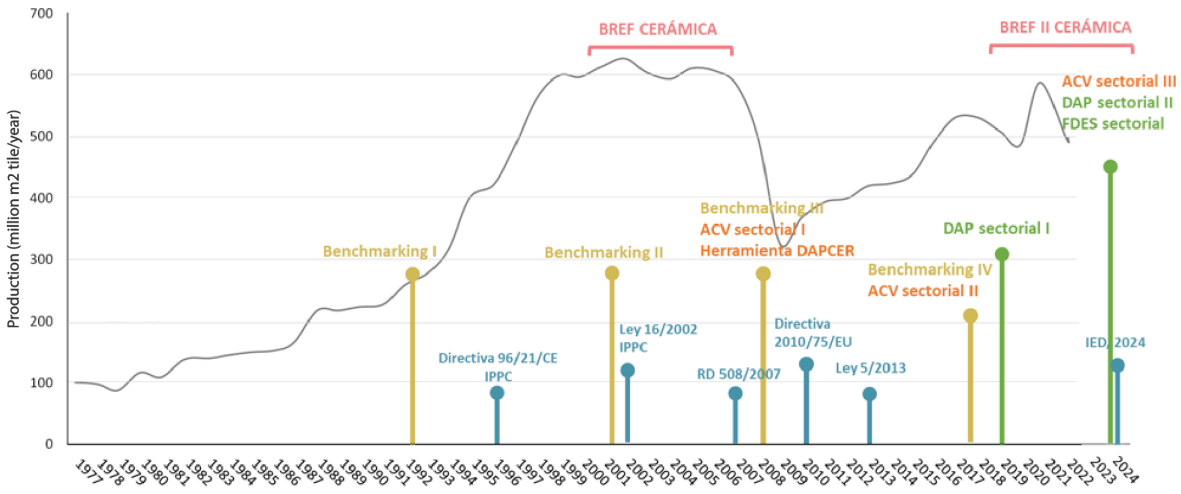

Figure 3. *Evolution of Spanish ceramic tile production since 1977 and time chart of ASCER's actions in the field of environmental studies.*

The methodology and information compiled in Benchmarkings I, II and III served as the basis for the first sector-wide LCA in 2008 and the development of a tool called DAPCER, promoted by ASCER with a view to making it easier for Spanish ceramic tile firms to produce their own individual EPDs [18]. The experience acquired in that work led to the first sector EPD for ceramic tiles (GlobalEPD 002-042) in 2019.

In 2024, the sector EPD will be updated in the GlobalEPD programme and the FDES will be registered in INIES. Despite the industry's current situation, representation of almost 55% of all Spanish production has been achieved, which shows how interested companies are in having this type of label.

These Declarations embody several new features compared to previous studies. One of the most noteworthy is the update of the UNE EN 15804+A2 Core product category rules for construction products, with modifications that bring it more in line with the European Commission's Product Environmental Footprint (PEF), designed to create a level playing field for all EU member countries and construction industries in general.

For practical purposes, the main modifications vis-à-vis the previous version mainly concern the methodology: mandatory minimum scopes depending on product type, calculation of biogenic carbon, environmental impact categories, data format according to international systems (International Life Cycle Data, ILCD), calculation of module D, and the method of analysing data quality. For ceramic tiles, the most significant changes are described in Table 1.

Concept	EN 15804+A1	EN 15804+A2
Scope[1]	Minimum: A1-A3 (cradle to gate) Optional: remainder	Minimum[1]: A1-A3 (cradle to gate), C (end of life) and D (benefits from revalorisation) Optional: A4-A5 (distribution and installation) and B (use)
Biogenic carbon	Optional	Compulsory as per calculation specifications for the product and packaging separately
Environmental impact categories	CML-IA 2012 (7 impact categories and 17 parameters that describe input and output flows)	EF 3.1. recommended by the EU in line with Product Environmental Footprints (PEF) (13 impact categories), plus 6 optional ones and 17 parameters that describe input and output flows.
Module D: *Benefits and loads beyond the system from reusage, recovery and/or recycling*		Improved description and specifications for calculation in a specific annex.
Data quality analysis		The method is specified.

1. In any case, the modules must be declared separately, except A1-A3, which can be declared jointly, if desired.

***Table 1**. Most significant differences in the application of the Basic Product Category Rules for Construction Products to ceramic tiles*

Last but not least is the reality of having the first sector FDES for ceramic tiles worldwide registered in INIES, a highly significant strategy bearing in mind the importance of the French market for the Spanish ceramic industry.

2.2. METHODOLOGY

In order to produce the sector EPD and FDES, a sector-wide LCA study was carried out.

Once the objectives and scope of the LCA study had been defined, including, among others, the types of products to be included, the source of the data and how the results would be expressed, a specific questionnaire was designed to collect information on the manufacture of spray-dried granules and ceramic tiles. The questionnaires collected information on different product types, productions, raw materials consumption, consumables, water and energy, and on the generation of air emissions and waste and their management. The data were processed at individual company level and weighted averages were then calculated for the whole sector's production.

With regard to the methods used for impact assessment and characterisation factors, those recommended by standard EN 15804+A2 included in the Environmental Footprint method were applied.

When interpreting the results, critical points shall be determined, and a contribution analysis shall be carried out to see which parameters have the greatest impact, followed by sensitivity analysis to determine the parameters that have the greatest influence on the results.

2.3. RESULTS

At the time this document/article is being written, the EPD verification and registration process has still not been completed, so the values shown below are preliminary.

Table 2 shows life cycle environmental impacts for ceramic tiles. The values refer to a Functional Unit, defined as "*1 m^2 covering of a surface (floors, walls and façades) in a residential scenario with ceramic tiles (21 kg/m^2 average weight) for 50 years*". The life cycle modules not shown are considered irrelevant.

Impacts	Units	Product	Distribution & installation		Maintenance	End of life		Benefits from RRR
		A1-A3	A4	A5	B2	C2	C4	Module D
GWP-GHG	[kg CO_2 eq.]	11.9	5.6E-01	1.5	2.3E-01	1.1E-01	1.1E-01	-2.1E-01
GWP-total	[kg CO_2 eq.]	12.1	5.7E-01	1.6	2.5E-01	1.1E-01	1.1E-01	-2.1E-01
GWP-fossil	[kg CO_2 eq.]	12	5.7E-01	1.6	2.4E-01	1.1E-01	1.1E-01	-2.1E-01
GWP-biogenic	[kg CO_2 eq.]	3.0E-02	-6.3E-03	-7.4E-04	2.0E-03	-1.5E-03	1.1E-03	-9.9E-05
GWP-luluc	[kg CO_2 eq.]	6.9E-03	4.3E-03	1.2E-03	1.8E-05	9.7E-04	4.7E-04	-5.6E-04
ODP	[kg CFC11 eq.]	2.0E-08	6.7E-14	1.0E-09	1.1E-07	1.4E-14	6.3E-14	-4.3E-09
AP	[mol H+ eq.]	2.9E-02	3.7E-03	3.6E-03	2.6E-03	1.0E-04	8.1E-04	-6.9E-04
EP-freshwater	[kg P eq.]	9.0E-05	1.7E-06	6.4E-06	6.0E-06	3.8E-07	2.3E-06	-1.7E-06
EP-marine	[kg N eq.]	9.3E-03	9.2E-04	1.2E-03	2.8E-04	3.1E-05	2.2E-04	-2.1E-04
EP-terrestrial	[mol N eq.]	1.00E-01	1.0E-02	1.3E-02	1.1E-02	3.7E-04	2.4E-03	-2.3E-03
POCP	[kg NMVOC eq.]	2.7E-02	2.7E-03	3.4E-03	1.9E-03	9.7E-05	6.5E-04	-5.7E-04
ADP-m&m	[kg Sb eq.]	5.8E-05	3.2E-08	3.1E-06	1.7E-08	7.0E-09	1.1E-08	-8.3E-08
ADP-fossil	[MJ]	182	7.5	15	1.5	1.4	1.5	-3.5
WDP	[m^3]	2.2	5.7E-03	0.2	13.7	1.3E-03	8.3E-03	-1.5E-03

Global Warming Potential, UNE EN15804:2012+A1: 2014 (**GWP-GHG**); Total global warming potential (**GWP-total**); Global warming potential of fossil fuels (**GWP-fossil**); Biogenic global warming potential (**GWP-biogenic**); Global warming potential from land use and land use change (**GWP-luluc**); Stratospheric ozone depletion potential (**ODP**); Acidification potential (**AP**); Freshwater eutrophication potential (**EP-freshwater**); seawater eutrophication potential (**EP-marine**); Eutrophication potential, cumulative surplus (**EP-terrestrial**); Photochemical Ozone Creation Potential (**POCP**); Abiotic resource depletion potential for minerals and metals (**ADP-m&m**); Abiotic resource depletion potential for fossil resources (**ADP-fossil**); Water deprivation potential (**WDP**).

(1): The results of these environmental impact indicators should be used with caution, as the uncertainties of the results are high and experience with this parameter is unlimited.

***Table 2**. Results of core environmental impacts for 1 m^2 ceramic covering over 50 years (Average values).*

The extraction and transport of ceramic body raw materials account for almost 40% of the emissions that eutrophicate fresh water (EP-freshwater) and almost 27% of the GHG emissions from land use and land use change (GWP-luluc); the other impacts do not exceed 14% of the life cycle total.

The manufacture of spray-dried granules accounts for around 20% of the impacts that deplete abiotic resources of fossil origin (ADP-fossil) and emissions that generate global warming (GWP), due to the consumption of natural gas in spray-drying; the rest of the impacts generated by this manufacturing stage do not exceed 8.5% of the life cycle total.

Tile manufacture is the stage that produces the largest contribution. Drying and firing (gas consumption, decarbonation and other hot emissions) account for about 50% of GWP and ADP-fossil and for 10-23% of the substances that acidify (AP), eutrophicate the environment (EP), or generate emissions of gases that photo-oxidise to form ozone in the troposphere.

Maintenance, which takes 50 years' cleaning into consideration, accounts for more than 85% of ozone depleting emissions (ODP) and water deprivation (WDP), owing to its use of detergent (defoamers in synthesis) and water consumption, respectively.

End-of-life is a relatively insignificant stage, the greatest impact of which is GPW-luluc (7.4% of the total), due to 30% of ceramic tiles being landfilled; the rest <2%.

3. POTENTIAL USES AND APPLICATIONS OF EPDs

One aspect to bear in mind during the conceptualisation, planning and execution of this type of study is how the results obtained are to be exploited, especially considering the effort and consumption of resources involved in doing the work.

In this sense, it is important to point out that the results obtained from the LCAs that support the EPDs, as well as the EPDs themselves, have a multitude of applications and utilities, both at sector level and at individual company level. The following section presents such possible applications from both viewpoints.

AT SECTOR LEVEL

- **Definition of improvement strategies at sector level**, since the product's strengths and weaknesses are identified and quantified, and arguments are made available with which to position the product on the market from an environmental standpoint.
- **Technology prospects**. It provides a basis for technology, energy, design or raw materials selection simulations, for example. Provides fundamental support for decision-making in order to define the sector's roadmap towards decarbonisation.
- **Arguments in funding negotiations**, as information provided directly by manufacturers is available, which is real, normalised and verified by independent third parties.
- **Support for the development of regulations and/or legislation**. In its ongoing process of revising reference documents, the European Commission takes the life cycle perspective into account. This makes it possible to assess the possible medium to long-term effects of using a new technology, setting a new limit value, etc.
- **Continuous and systemic assessment through benchmarking** to improve the environmental performance of the sector as a whole.
- **Comparison with industries that have the same functionalities**, to determine strengths and weaknesses with respect to competing materials and enable use in defining marketing strategies.

AT INDIVIDUAL COMPANY LEVEL

- **Marketing arguments**. It allows companies to compare themselves with other firms in the same sector (ceramic tiles) or with other companies in covering materials sectors competing with ceramic tiles.

- **Access to projects or funding**. Having EPDs and/or an FDES gives companies access to tender processes or funding programmes where this type of eco-labelling is recognised.
- **Negotiation of legal limits for specific individual situations**. The availability of environmental information verified by a third party is of great value in environmental regulation review processes, as it allows for cross-effect analysis of new regulations and for assessing returns in terms of environmental benefit.
- **Safeguards the confidentiality of sensitive data**. One of the great advantages of LCA studies is that they make it possible to "translate" and reduce the environmental data of individual companies into a series of globally recognised environmental indicators. Therefore, EPDs and an FDES provide a means of reporting all environmental product information without the need to publicly disclose information that the company may consider sensitive.
- **Continuous and systemic evaluation through benchmarking**. Both the inventory data and the results of the impact assessment allow companies to measure themselves in regard to other companies in the same sector for continuous improvement.

4. CONCLUSIONS

The availability of real and updated environmental information is essential to improving the sector's competitive position; moreover, it is a very powerful tool for tackling difficulties and detecting alternatives and options for improvement.

The Spanish ceramic tile industry will have at its disposal a sector-wide LCA, EPD and FDES study, which brings multiple benefits: it enables the product and sector's environmental profile to be improved, the roadmap for decarbonising the industry and other relevant strategies to be defined; it provides access to building projects and financing programmes, and compares the position of both the sector and its companies with regard to alternative materials, thus increasing competitiveness, among other advantages.

5. ACKNOWLEDGEMENTS

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