

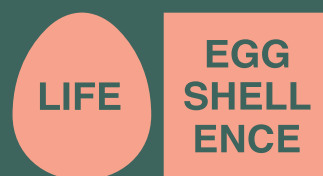
Layman's report

LIFE EGGSHELLENCE
(REF.: LIFE19 ENV/ES/000121)

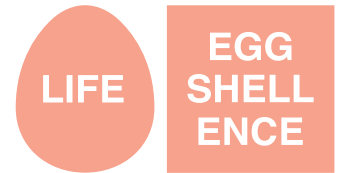


INDUSTRIAL SYMBIOSIS BETWEEN EGG-PROCESSING COMPANIES AND CERAMIC COMPANIES

lifeeggshellence.eu



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Project Information

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LIFE EGGSHELLENCE consortium

Project coordinator



Instituto de Tecnología Cerámica (ITC-AICE)

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Project beneficiaries



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www.bekoetxe.com



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1. WHAT IS THE LIFE PROGRAMME OF THE EUROPEAN UNION?

LIFE is the EU's funding instrument for environment and climate action. The general objective of LIFE is to contribute to the implementation, updating and development of EU environmental and climate policy and legislation by co-financing projects with European added value.

2. WHAT IS THE MAIN PURPOSE OF LIFE EGGSHELLENCE?

The project's main purpose is to demonstrate the technical feasibility of using **eggshell** as a **secondary raw** material in wall tiles manufacturing. This project proposes a new product for ceramic companies, which is the **bio-CaCO₃** obtained from the eggshell.

The LIFE EGGSHELLENCE project arose from an identified issue of the egg processing industry, as it is estimated that around 150,000 tons of eggshells are generated in Europe and almost the totality is not recycled and destined for landfill. They often cause problems, such as bad odours or the growth of bio-organisms that generate complaints or even legal claims. Spain and Portugal, the countries involved in the LIFE EGGSHELLENCE project, currently produce 5,500 tons of eggshell waste per year in the case of Portugal and 16,000 tons per year in the case of Spain. In these countries, more than 90% of this solid residue is estimated to

be disposed in landfills, with transport and treatment or landfilling associated costs arising from 25 to 200 €/ton. This can induce costs of the order of 50,000-100,000 € per year in the case of small or medium sized egg-processing companies.

The solution proposed in this project will help the egg processing companies and ceramic companies to move towards a circular economy model and to promote the industrial symbiosis between both sectors.

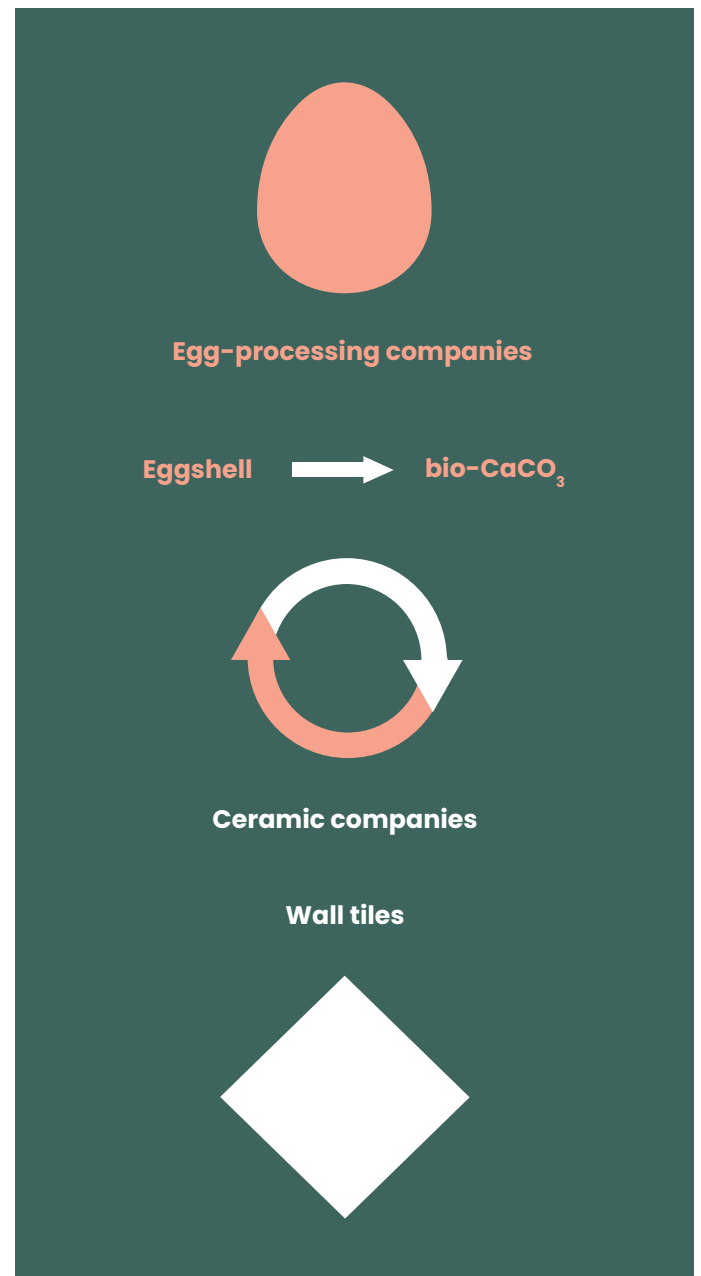
We have pursued our goal by developing a prototype which will separate the membrane from the eggshell. The resulting eggshell will be used as secondary raw material in substitution of mineral calcium carbonate, which is used in percentages between 10 and 15% in the spray-dried powders used for manufacturing ceramic wall tiles.

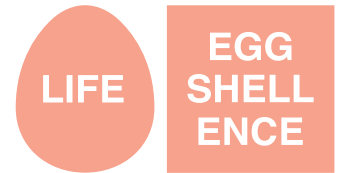
By means of the process designed in LIFE EGGSHELLENCE for the separation of the

membrane (which could generate defects in the ceramic tiles), the ceramic industry could absorb in both countries and at European level the totality of eggshells produced by the egg processing industry.

The specific objectives have been:

- To **develop a prototype** for the pre-treatment of eggshell, **that separates the membrane from the eggshell, obtaining the bio-CaCO₃**, by a simple and low-cost process.
- To demonstrate the **valorisation of the bio-CaCO₃** in the ceramic tile production process.
- To implement the circular economy concept through industrial symbiosis between egg processing companies and ceramic companies (spray-driers and tile producers).
- To determine economic benefits for both sectors.
- To develop a **new business model for the egg processing industry** as supplier for the ceramic industry.
- To verify the **absence of environmental impact of the use of bio-CaCO₃** on the production of ceramic wall tiles compositions and, subsequently, on the wall tiles production as well as in the membrane separation process.
- To check the **beneficial impact on the Life Cycle Assessment** of the ceramic wall tiles.
- To **transfer the acquired knowledge** regarding the innovative valorisation scheme to both egg processing industry and spray-driers and tile producers.
- To **foster social awareness** related to the environmental problem caused by eggshells nowadays and the new situation after this project.





3. WHAT HAVE WE DONE AT LIFE EGGSHELLENCE?

The project ensures the use of high-quality secondary resources from a bio-based by-product, as the treated eggshell obtained after the separation process (bio-CaCO₃) has been integrated in the ceramic compositions.

The project includes actions at laboratory and industrial level to put into practice, demonstrate and disseminate a solution for producing bio-CaCO₃ as an alternative raw material in substitution of mineral calcium carbonate.

Actions developed are shown in the following chart:

<p>A1. State-of-the-art A1.1. Legal analysis and mapping A1.2. State-of-the-art technology</p> <p>B1. Design of the prototype for the separation of the membrane from the eggshell B1.1. Testing of separation systems B1.2. Construction and prototype validation</p> <p>B2. Pre-industrial scale tests of ceramic wall tiles production with eggshell B2.1. Design of wall tile body compositions with bio-CaCO₃ B2.2. Validation of wall tile body compositions with bio-CaCO₃</p> <p>B3. Industrial trials B3.1. Production of wall tile bodies B3.2. Production of wall tiles B3.3. Technical evaluation of the wall tiles produced</p> <p>B4. Replicability strategy B4.1. Business plan B4.2. Replicability and transfer plan</p>	<p>C1. Environmental analysis and legal requirements</p> <p>C1.1. Environmental analysis</p> <p>C1.2. Legal implications for the use of bio-CaCO₃</p>	<p>D1. Dissemination and awareness raising</p> <p>D1.1. Dissemination plan</p> <p>D1.2. Networking</p> <p>D1.3. Awareness raising campaign</p>	<p>E1. Project management</p>
	<p>C2. Life indicators and project indicators</p> <p>C2.1. Monitoring LIFE KPI's</p> <p>C2.2. Monitoring progress project indicators</p> <p>C2.3. Monitoring socioeconomic impacts</p>		<p>E2. After-Life plan</p>



A1,B1,B2,B3,B4,C1,C2,D1,E1,E2

A1,B1,B2,B3,B4,C1,C2,D1,E1,E2



A1,B2,B3,B4,C1,C2,D1,E1,E2

B2,B3,B4,C1,C2,D1,E1,E2



A1,B1,B3,B4,C1,C2,D1,E1,E2

B2,B3,B4,C1,C2,D1,E1,E2

Preparatory action (A1) developed allows to determine the environmental and administrative legislation that can affect the project realisation and implementation

(action A1). A map with all the identified egg processing companies and ceramic tile companies (those which can use the bio-CaCO₃) from Spain and Portugal

was elaborated including other ceramic companies such as brick and roof tiles producers as they can become potential users of this new secondary raw material. In addition, the actual legal framework in Europe, and more specifically, in Spain and Portugal, for the use of eggshells in ceramic tile production was described. Finally, a state of the art of the technologies for the separation of the organic membrane from the eggshell was done and used for the definition of the separation process in Action B1.

The implementation actions (B1 to B4) are the core of the project. They include a) the **design of the prototype** for the separation of the membrane from the eggshell as well as the construction and validation of the prototype, which is installed in AGOTAZAINA (action B1) for obtaining bio-CaCO₃, b) **the development and characterisation of the compositions** with the new bio-CaCO₃ that were used in pre-industrial trials in Spain and Portugal (action B2), c) **industrial trials of wall tile production with bio-CaCO₃** to get reliable data in an industrial environment, considering resources inputs, emissions and products obtained (action B3) and finally d) two **business plans** for MAINCER and AGOTZAINA were developed and **a replication strategy** towards other companies in Europe has been developed (action B4).

The monitoring actions (C1 and C2) have allowed to measure the performance indicators. Within the framework of action C1, a **Life Cycle Assessment (LCA)** of the bio-CaCO₃ and self declared environmental claims of the spray-dried powders with bio-CaCO₃ have been developed, together with the compilation

of those criteria applicable to the new wall tiles with bio-CaCO₃ that are required for buildings to be certified as sustainable. In addition, a study of **legal implications for the use of bio-CaCO₃** in ceramic wall tiles has been carried out with the aim of ensuring the implementation and commercialization of this new raw material for the ceramic sector.

Action C2 encompassed the following up of the LIFE KPI's and progress indicators as well as the monitoring of socioeconomic impact of the project.

Other key actions that are essential for the implementation the project results are those related to its **communication and dissemination (Action D1)**. A **communication plan** has been developed, which encompasses all activities aimed at effectively transmitting the benefits of the new alternative raw material to industries, citizens, decision-makers and planners. The main communication channel through which the information has been collected and transmitted is the project website: www.lifeeggshellence.eu where information related to both the development of the project and its results is available through videos, documents, press releases, etc...The website design, the corporate image of the project and the awareness raising campaign are crucial for implementation and engage a high number of stakeholders.

There is a clear commitment reflected in the **After Life Plan (Action E2)** that the website will be kept up to date to keep users informed of all project activities and impacts and for ensuring the sustainability the project beyond its end.

4. MAIN RESULTS

4.1. MAP OF EGG PROCESSING INDUSTRIES AND CERAMIC COMPANIES IN SPAIN AND PORTUGAL.

A list of the egg processing companies and ceramic companies from Spain and Portugal has been obtained and several maps including these companies have been built. The list includes an estimation (in tons) of the eggshell waste generated per year by some of the egg processing companies identified and the distance

between these companies and the closest ceramic cluster in Spain and Portugal.

4.2. DEVELOPING A PROTOTYPE FOR SEPARATING THE MEMBRANE FROM THE EGGSHELL.

- A prototype has been developed by MAINCER for the separation of the membrane from the eggshell.
- The bio-CaCO₃ obtained is almost free of membrane.

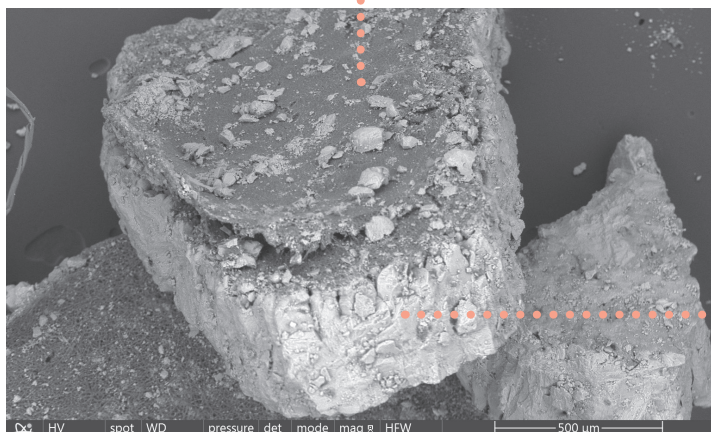


- The prototype is installed in AGOTZAINA and can process 10 tonnes eggshell/ day working in a continuous mode, this being the amount of eggshell generated daily in AGOTZAINA.
- Around 50% of total recovery of bio-CaCO₃ has been achieved with the prototype working regularly and 75% of total recovery of bio-CaCO₃ with a second processing with the same efficiency in the removal of the membrane.

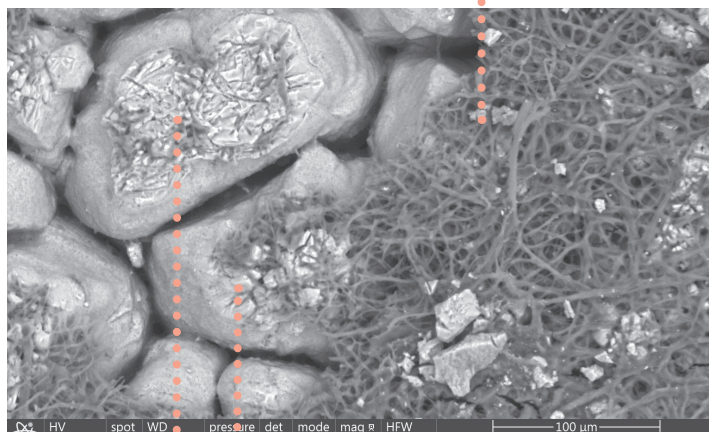


Prototype built and installed in AGOTZAINA.

Membrane



Eggshell particles with the membrane prior to its separation



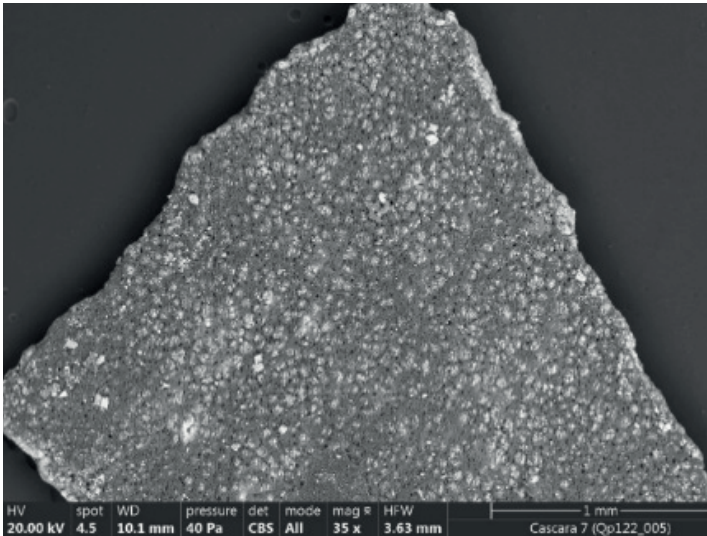
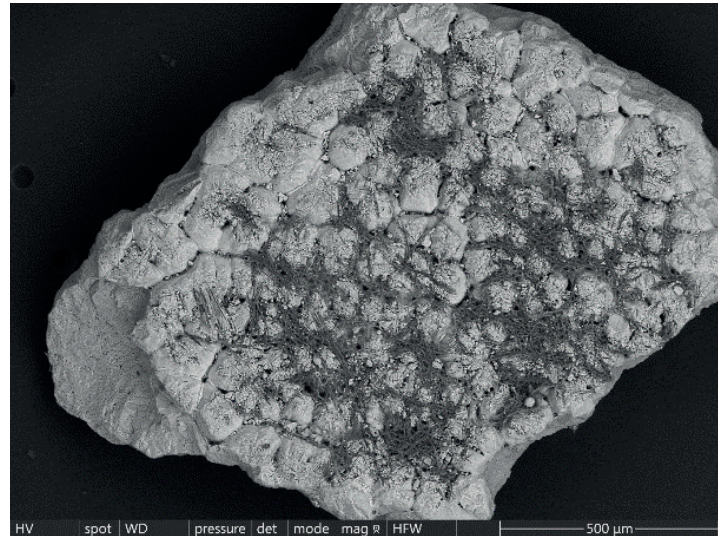
Bio-CaCO₃

4.3. BIO-CACO₃ AS RAW MATERIAL.

- The characterization of the bio-CaCO₃ obtained confirms the almost complete absence of membrane in the structure.
- The bio-CaCO₃ obtained is composed of 94.5% of CaCO₃, 0.7% of MgCO₃, 1.3% of Ca₃(PO₄)₂ and 3.5% of organic matter.



Image of the resulting bio-CaCO₃

Micrography of bio-CaCO₃

4.4. INDUSTRIAL TRIALS IN SPAIN AND PORTUGAL

Once defined optimum compositions by UA, ITC-AICE, EUROATOMIZADO and ADM, industrial trials were successfully performed. Firstly, industrial milling and spray-drying of compositions with bio-CaCO₃ have been carried out in EUROATOMIZADO and in ADM. Secondly, wall tiles have been

manufactured in ceramic tile producers with no defects and almost no changes required in the manufacturing process.

Spanish case:

- 40 tons of spray-dried powder with 5% of bio-CaCO₃ (approximately 1/3 of total calcium carbonate).
- 2000 m² of wall tiles (30x90 cm)



Spray-dried powder obtained.



Wall tiles 30x90 cm.

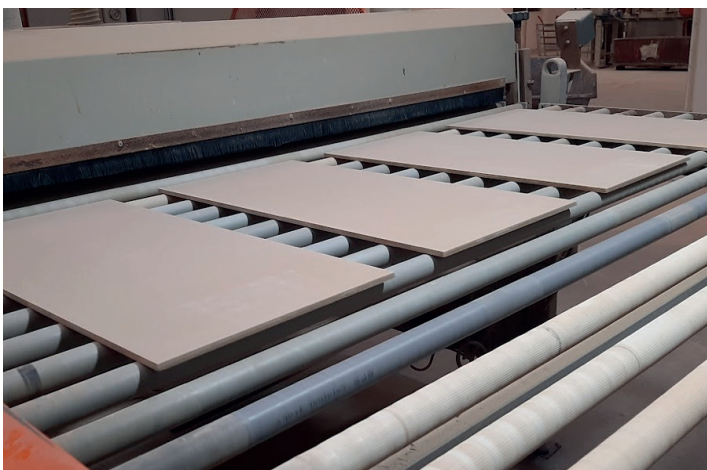


30x90 cm tiles glazed and fired at industrial scale.

Portuguese case:

- 40 tons of spray-dried powder with 6-8.5% of bio-CaCO₃ (between 50 and 60% of total calcium carbonate).
- 1000 m² of wall tiles (30x60 cm) and 1000m² of 15x15 cm wall tiles.

All the tiles produced with the compositions with bio-CaCO₃ have the same properties as those manufactured only with mineral calcium carbonate.



The pressed tiles dried and entering in the glazing line at about 85°C



Fired wall tiles without glaze (left STD, right REVC 6231-23E50).

4.5. DISSEMINATION AND COMMUNICATION ACTIVITIES

During the project execution, the beneficiaries have participated in several dissemination and communication activities, for sharing the project results. Despite the pandemic circumstances, several activities with high impact have been developed: The project has been communicated in 52 events.



Ceramic Technology Conferences. Organised by CTCV, APICER, SPCV and UA. Aveiro (Portugal), 2021.



Infoday “Sustainability within the ceramic sector”. Online and onsite event (4/11/2021). Organised by ITC-AICE and UJI. Castellón (Spain), 2021



International Conference EUWEP–General Assembly of the EUWEP (European Union Of Wholesale with Eggs, Egg Products and Poultry and Game). Madrid (Spain), 2022



1st annual meeting of the Industrial Symbiosis Observatory of the Valencian Community. “Industrial symbiosis and territory. Organized by Confederation Empresarial Comunidad Valenciana. Valencia (Spain), 2022



TECNARGILLA 2022 International Trade Fair TECNA-Rimini-presented at the MAINCER Stand. Rimini (Italy), 2022



TOP Insiders Awards 2022. LIFE EGGSHELLENCE was finalist in the category of "Smart Business Transformation". Madrid (Spain), 2022.



MATSUS & STECH Conference. (Materials for Sustainable Development Conference). Valencia (Spain), 2023.



International Trade Fair CEVISAMA. Valencia (Spain), 2023



International Conference of European Clay Groups Association- EUROCLAY. Bari (Italy), 2023.



Final Event of the project. European Commission. Representation in Spain, headquarters. Madrid (Spain), 2024.

4.6. STAKEHOLDERS ADVISORY BOARD

Stakeholders Advisory Working Group was created in December 2020. An Advisory Board whose motivation is to detect the needs and interests of the egg processing industries.

The entities involved are associations and egg-processing and ceramic companies that have shown their commitment to study the replication of the project. Efforts have also been made to involve as much as possible waste management authorities to be part of this board and support the implementation of the solution developed in the project.



4.7. NETWORKING

Many networking actions have been carried out during the project but the most important one is the synergy found with LIFE BYPROTVAl thanks to an EU LIFE Regional Infoday held in Valencia in 2021. LIFE BYPROTVAl studies the valorisation of animal by-products and in the framework of a networking action the feasibility of use of the membrane from the eggshell was determined. It was concluded that the egg membrane treated by enzymatic hydrolysis, could find application as a protein biopolymer in different industrial applications.

As a result of this networking action, a new regional project: OVOVAL has been proposed and funded, whose objective is to develop ceramic frits and shoe soles from the bio-CaCO₃ of eggshell and bio-fertilisers and retaining agents from the proteinic fractions (membrane and egg white and yolk). This project helps to achieve 100% recovery of the eggshell, thus closing the circle together with LIFE EGGSHELLENCE.



4.8. REPLICABILITY AND TRANSFERABILITY PLAN

The objective of this action was to demonstrate the feasibility of replicating project solution in other companies and sectors. This strategy is focused on the separation equipment developed in the project and on the bio-CaCO₃ as new alternative raw material.

Currently, the consortium is working on reaching an agreement and implementing the membrane separation equipment in 6 egg-processing companies, all of them have expressed their interest in the solution and have established contact with MAINCER for acquiring the new equipment. This objective will be reached during the next five 5 years beyond the end of the project.

The bio-CaCO₃ arises interest as an alternative raw material for being used in other industrial sectors besides ceramic sector. This represents a business opportunity for AGOTZAINA to enter in other markets. The potential industrial sectors identified are pharmaceutical, animal feed, construction and building materials (as bricks, roof tiles...) food and beverages...

EUROATOMIZADO and ADM will promote among their clients the spray-dried powder obtained with the new bio-CaCO₃, by creating a new environmentally friendly product for environmentally conscious customers.

Bio-CaCO₃ has been accepted in Portugal for not computing in the CO₂ emissions associated with the firing of the wall tiles manufactured with this secondary raw material due to its organic origin. The same consideration in Spain is still pending.

5. SUSTAINABLE DEVELOPMENT GOALS

LIFE EGGSHELLENCE aligns with the objectives set by the European Commission as well as with the Sustainable Development Goals set by the United Nations (SDGs). Specifically, LIFE EGGSHELLENCE is aligned with:

SDG 9: Industry, Innovation and Infrastructure. The LIFE EGGSHELLENCE project aims to modernise the infrastructure of egg production enterprises and convert them into more sustainable industries by installing a machine to separate the eggshell from the membrane. By using resources more efficiently and promoting the adoption of clean and environmentally sound technologies and industrial processes, all countries will be able to take action according to their respective capacities.

SDG 12: Responsible consumption and production. The project manages to considerably reduce the generation of waste from egg production companies through prevention, reduction, recycling and reuse activities by transforming eggshell waste into bio-carbonate. At the same time, a more sustainable management and efficient use of natural resources is achieved by the ceramic sector, as it allows the partial substitution of mineral carbonate by bio-carbonate from eggshell in the manufacture of ceramic tiles, reducing the extraction of mineral carbonate. It also encourages national and international companies to adopt sustainable practices and incorporate sustainability information into their industrial process.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



12 RESPONSIBLE CONSUMPTION AND PRODUCTION



SDG 17: Partnerships for the goals. In this project we have partnered technological centres, universities, egg production companies, ceramics, machinery and spray-drying companies in Spain and Portugal in order to avoid extracting virgin raw materials from nature, in this case calcium carbonate, and to reduce the deposit of eggshell generated by egg production companies in landfills. In this way, we establish alliances and help to respect the planet through a model of industrial symbiosis and circular economy, creating new products from waste. Furthermore, the project's Advisory Board is a clear example of cooperation between companies and associations from both the egg production and ceramics sectors in order to make progress in terms of sustainability in both sectors.

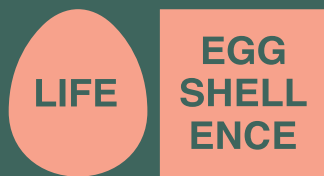
17 PARTNERSHIPS FOR THE GOALS



The project was recognized at the GoODS! Awards of the UN Global Compact Spain and the Rafael García del Pino Foundation, for its relation to SDG 9: Industry, Innovation and Infrastructure (www.reconocimientosgoods.com)



GoODS! awards ceremony granted by the Rafael del Pino Foundation. LIFE EGGSHELLENCE was the best project in the category



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