



LIFE16-ENV/ES/000258

EPS Sustainable Recycling



LIFE EPS-SURE

After Life Plan 2020 -2025

Partners:





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Prepared by:	CICLOPLAST (Isabel Goyena) CICLOPLAST (Mayca Bernardo) ANAPE (Raquel López)
Collaborators/reviewers:	COEXPAN (María Rodríguez) EL CORTE INGLES (Brezo Tejerina)
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PROJECT DATA

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Total Budget	1,467,074
EU Contribution	870,934 - 59.37%
Name of the Beneficiary Coordinator	CICLOPLAST
Name of the associated beneficiaries	ANAPE, COEXPAN, EL CORTE INGLES, TOTAL PETROCHEMICALS IBERICA (TPI), RTP
Contact Person	Isabel Goyena García-Tuñón
Email	isabel.goyena@cicloplast.com
Project website	http://www.life-eps-sure.com/



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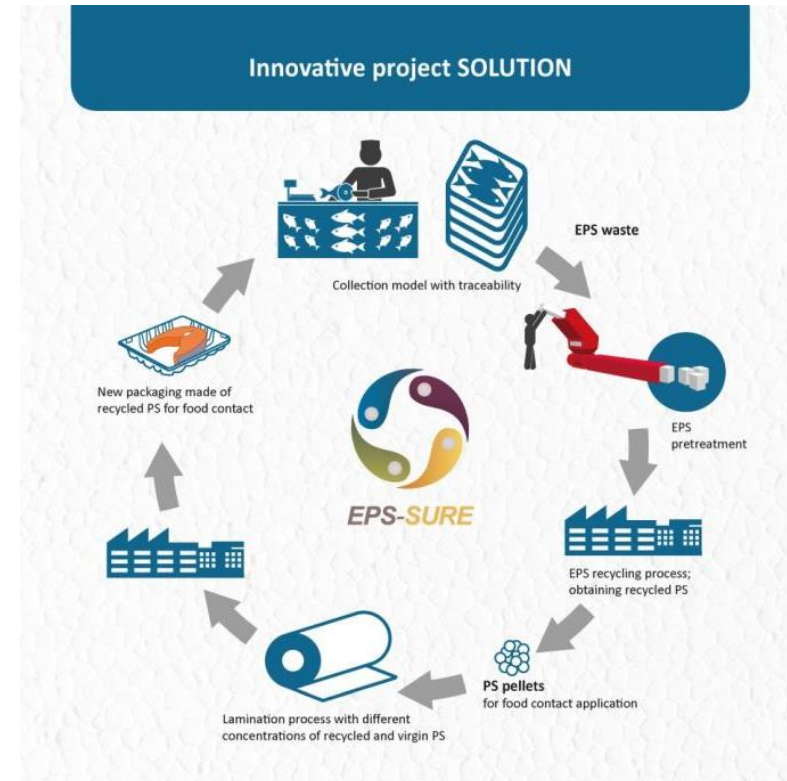
1 Introduction and objectives

Plastics are in the midst of a revolutionary process to implement a circular economy in how they are manufactured, used and managed, and over the coming years face major challenges in order to increase recycling levels to 55% by 2030, to reduce the amount sent to landfill, and in short to increase their circularity.

In order to expand recycling various conditions must be met, one of the essential factors being that high-quality recycled plastic material is ultimately obtained for use in new products. One of the options that give greatest value to recycled plastic is if it can be used as a food-grade raw material, since this status offers many more potential uses, with the possibility of competing against virgin material. At present there are very few recycled polymers (mainly PET) which have managed to attain such grades for use in food packaging.

The LIFE EPS SURE project was set up with the aim of offering a complete and innovative solution to recycle fish boxes made from Expanded Polystyrene (EPS), transforming them into polystyrene (PS) food contact packaging, thereby turning waste into highly valuable resources, and so avoiding landfill and littering.

Expanded polystyrene (EPS) boxes are typically used as containers to store, transport and present fresh produce such as fish, thanks to their outstanding properties in terms of thermal insulation, protection and food safety. EPS boxes are technically 100% recyclable, although many end up in landfill throughout Europe because the solutions to recycle them give rise to low value-added products. LIFE EPS SURE is aiming for a recycled product that can be used in higher value-added applications, specifically packaging and products that are in contact with food.





Project Objectives

The main objective of the project is to provide a complete and innovative solution to successfully recycle EPS fish box waste into PS food contact packaging, and to turn waste into valuable resources avoiding littering and landfill.

1. Offer a technical, environmental and affordable solution that allows the recycling of EPS FISH BOXES in order to be converted into new rPS **food contact packaging**, thus closing the loop.
2. Define a model to collect wash and recycle EPS fish boxes into food graded PS in a technical and economic profitable way
3. Demonstrate the EPS RECYCLING PROCESS, obtain 4-5 tons of recycled PS with different concentrations of recycled material, and produce prototypes of food contact packaging
4. Assist in fulfilling the new requirements in the European Legislation : Waste frame work Directive, Packaging Directive, Single Use Plastic Directive
5. Transfer and replicate the process in other EU countries with similar problematic





2 Actions and Results of the project

2.1 Actions objectives and results summary

Action A1 Detailed assessment of legal and operational aspects at EU level

Objectives: Assess legislative framework regulation to transfer the methodology to other EU countries (Italy, UK, and Greece). Portugal was also included as a study country for this action.

Results: Deliverables with legal and operational procedures of 3 EU countries Italy, Portugal and Greece.

Action A2 Analysis of the different logistic models existing and definition of procedures to handle and manage EPS waste

Objectives: Analyze the different logistic models in Spain related to the waste management procedures and establish a methodology that could be approved by EFSA.

Results: Overview in Spain on the collection procedures depending on the source and a developed waste management procedure.

Action A3 Procedures establishment and staff training for handling and managing EPS fish boxes

Objectives: Procedures and Training of staff in ECI, TPI and SAICA, ACTECO (subcontractors)

Results: Procedures of the different tasks. All staff involved in the fish boxes collection and treatment is aware of the procedures and methodology.

Action B1 EPS fish boxes collection, washing and pre-processing

Objectives: EPS fish boxes collection, washing and pre-processing

Results: 8 tn fish boxes have been collected and pre-treated in a close loop with traceability.

Action B2: Design and adaptation of the EPS recycling Demonstrator.

Objectives: Design and adaptation of the EPS recycling. Demonstrator at TPI's pilot plant, purchase the required pieces, set-up the demonstrator.

Results: Pilot plant adapted and ready to start the demonstration.

Action B3: Set-up and Demonstration of the EPS recycling process to PS

Objectives: Demonstration of EPS recycling process to PS.

Results: 8 tn of recycled food contact graded PS. Mechanical tests, Challenge tests and migration tests with positive results.

Action B4: Design and adaptation of the Demonstrator for the PS transformation process to food contact PS sheets

Objectives: Design and adaptation of the demonstrator for PS transformation to food contact PS sheets at COEXPAN's plant.

Results: industrial plant's processing line adapted for EPS SURE demonstrator.



Action B5: Demonstration of the PS transformation process to food contact PS sheet

Objectives: COEXPAN's demonstration of the PS transformation process to food contact PS sheet.

Results: The demonstration has been performed in RTP the industrial plant of the group COEXPAN located in Huelva (Andalucía).

4 tn of recycled PS has been treated to obtain 16 PS sheets thermoformed to 36 food contact packaging prototypes. Migration tests and NIAS¹ Tests with good positive results, no migration to the food. The material could be used for food contact packaging according to tests.

Action B6: Precertification of the LIFE EPS SURE process according to protocols and regulatory standards for food contact process

Objectives: Pre-certification of the process and elaboration of the Good Manufacturing Practices definition.

Results: Good manufacturing practices development for collection, pretreatment and treatment.

The **documentation for precertification with EFSA** has not been prepared because the TPI plant in el Prat de Llobregat has been shut down in December 2019 due to the reduction of the PS market in Europe.

Action B7: Feasibility study and business plan

Objectives: Prepare the market uptake with the following activities (Market analysis, Feasibility study, Business plan, Upscale of the EPS SURE production process)

Results: Market analysis and economic viability analysis. Results for the economic viability is negative, costs for collection and pretreatment of EPS are very high and market and prices of PS have been reduced due to the Directive (EU) 2019/904 on the reduction of the impact of certain plastic products on the environment, which has prohibited several products made of PS as plates and cutlery and the reduction of food contact packaging. The report upscale of the pilot plant has not been prepared as no industrial plant is going to be constructed due to the negative economic results.

Action B8: Transferability and replicability

Objectives: Transferability and replication Plan for implementing the LIFE EPS SURE methodology

Results: As no industrial plant for the recycling of PS is going to be constructed the transferability and replicability plan has not been performed.

Action C1: Effectiveness of the project actions in regards to the initial situation

Objectives: Environmental monitoring of the project actions, Socio-economic monitoring of the project actions.

Results: assessment of the environmental and socio-economic impact with objective values. LCA report.

Action D1 D2 Dissemination, communication and networking

Objective: Develop an effective communication and dissemination plan and prepare all required material. Dissemination activities

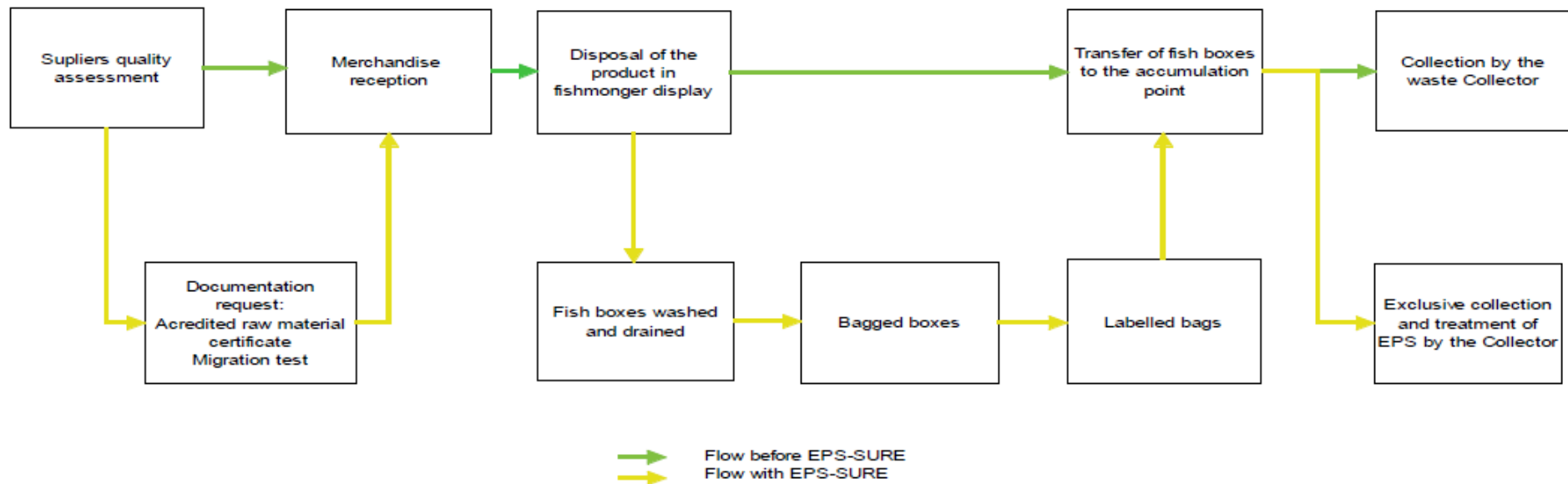
Results: Communication and dissemination plan, Dissemination material, elements and means. Raise stakeholder's awareness, networking activities.

¹ Non-intentionally added substances (NIAS) are chemicals that are present in a food contact material (FCM) or food contact article (FCA) but have not been added for a technical reason during the production process. NIAS could migrate from the FCM or FCA into food, but it is very difficult to completely understand and control such processes.

2.2 Results

EL CORTE INGLES

8 t of EPS fish boxes have been collected in El Corte Inglés. The closed loop traceability ensures that the origin of the material that is going to be recycled has more than 99% food-contact quality content. The diagram of EPS collection in El Corte Inglés represents the changes taken in procedures for the EPS SURE project comparing to the normal operation.





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EPS-SURE – IMPACTS IN ECI

In the stores

To guarantee the traceability of fish boxes:

- We have to control that the 100% of our suppliers used accredited raw material for the manufacture of fish boxes:
 - Accredited raw material Certificate
 - Migration test
- We have to train fishmongers in the new way of managing the fish boxes
(Fish boxes stops being a waste and becomes a raw material)
- We have to introduce a new way for the manage of fish boxes:
 - Washed
 - Drained
 - Bagged
 - Labelled



TOTAL PETROCHEMICAL

8 tones have been pre-treated and recycled in Acteco (washing and shredding) and TPI plant (decontamination)

The Challenge Test evaluation of the decontamination process, following similar criteria as those used for PET and approved by EFSA, demonstrates the complete efficiency of the decontamination for dairy sheet application, and even 100% of this recycled material can be used to this end (after EFSA authorisation).



RECYCLED PROCESS: CLOSED LOOP



STEP 1.- Pre-treatment



Transformation EPS briquettes to flakes

Hot caustic washing in controlled conditions (concentration, temperature and contact time)

- Centrifugation
- Hot air drying

STEP 2.- Decontaminator

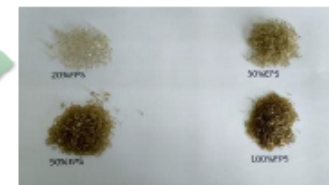


Hoppers collecting EPS flakes and QPPS pellets

Mix and melt materials

Controlled conditions of temperature, vacuum, material surface/volume ratio and residence time

20,30 & 50% rPS samples



**Challenge tests results from the TOTAL PETROCHEMICAL PROCESS performed by AIMPLAS laboratory.**Comparison C_{mod} & C_{res} obtained for recycled EPS, yogurt sheet application

Substance	Efficiency (%)	C_{res} (mg/Kg)	C_{mod} (mg/Kg)	$C_{res} < C_{mod}$
Chloroform	99,9	0,008	2,38	Yes
Toluene	99,5	0,025	1,90	Yes
Phenyl cyclohexane	89,6	0,872	3,17	Yes
Benzophenone	80,9	1,602	3,74	Yes
Methyl stearate	40,7	4,973	7,46	Yes
Copper ethyl hexanoate	80,7	1,619	9,76	Yes

As the C_{res} values $<$ C_{mod} values the decontamination efficiency has been demonstrate
100% of the recycled material can be used for this purpose

All substances listed in Regulation 10/2011 are at a concentration below the specific migration limit and in the case of substances not listed in the Regulation, the concentration of the substances detected is below the limit set for Cramer class III substances (worst case, 90 ppb) and below the threshold of 10 ppb. Therefore, all substances detected are present in a concentration in mg/kg of food that is considered safe for consumer.

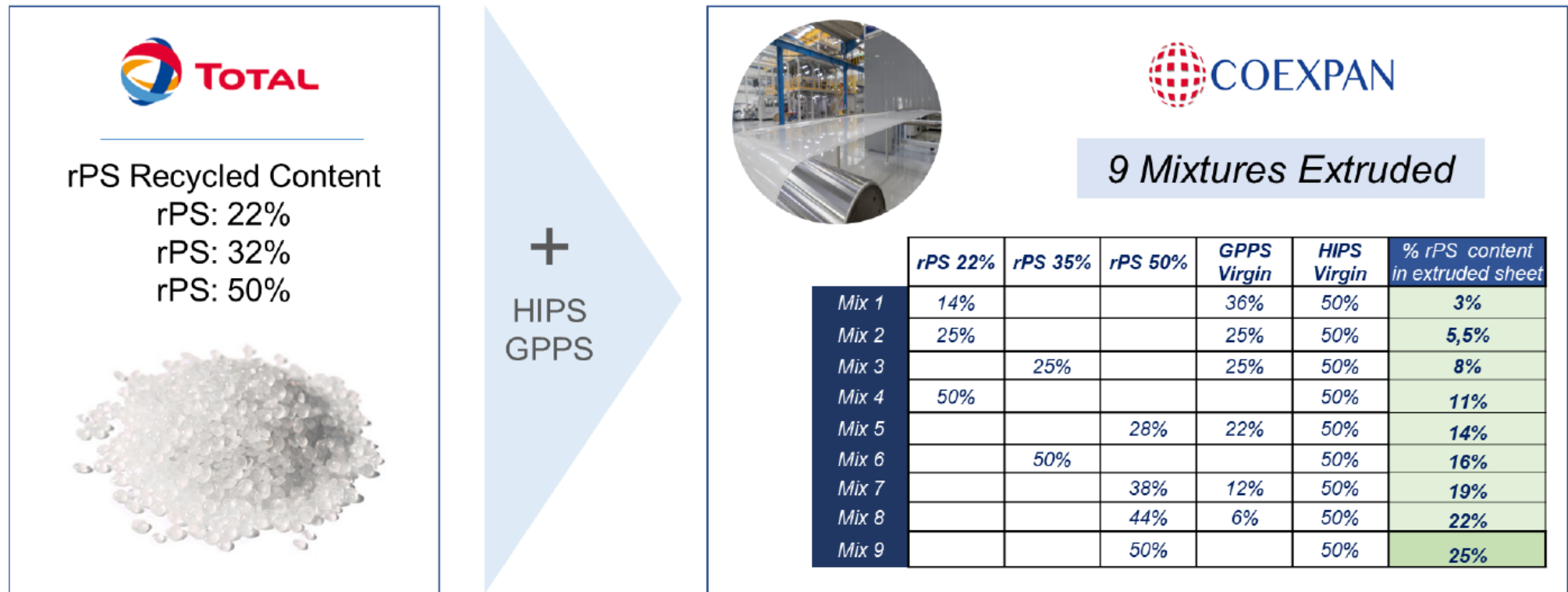


COEXPAN

4 tonnes of rPS material from TOTAL have been processed in COEXPAN to perform rPS sheets for dairy products.

The migration tests that have been carried out to the rPS content sheet which is used to produce the packaging prototypes, have demonstrated that it fulfils the European food contact reference regulations.

The mechanical tests that have been carried out have demonstrated that the rPS material behaviour is similar to virgin material



1

TEST PERFORMED ON THE SHEET DURING EXTRUSION



MECHANICAL

- 1. Thickness control ✓
- 2. Contraction control ✓
- 3. Arrow control ✓
- 4. Tail Effect (Corrugation) ✓



COLOUR

	ΔE
M2	1,61
M3	3,75
M4	3,78
M5	9,58
M6	6,92
M7	10,79
M8	14,31
M9	17,17

ΔE : Total color difference between standard (M1) and sample.





POSITIVE RESULTS

- 1. *Process Parameters* ✓
- 2. *Mechanical Properties* ✓
- 3. *Food Safety* ✓

TESTS PERFORMED AT EXTERNAL LAB (AIMPLAS)



COMMISSION REGULATION (EU) No 10/2011

of 14 January 2011

on plastic materials and articles intended to come into contact with food

(Text with EEA relevance)

MAIN TESTS

GLOBAL MIGRATION



SPECIFIC MIGRATION



NIAS



FSSC 22000



FDA

ecovadis



ECONOMIC VIABILITY

A viability economic analysis has been performed considering all phases. From the economic perspective, the results of the economic analysis have been less satisfactory than expected. The management cost incurred in the project reveals a deficit of 543€/t with a mix of 20% recycled EPS, while the deficit amounts to 1527€/t with 50% recycled EPS. This increase is the result of the higher-than-expected costs in collection and pre-washing at the waste generation point, in compacting (at SAICA) and the washing treatment (at ACTECO).

LIFE CYCLE ANALYSIS

The Cradle-to-Gate life-cycle analysis studies are positive². In general terms, in replacing Styrene with recycled EPS, the new PS generated broadly reduces the impacts studied in the LCA by between 20% and 40%.

ATF	Acidification terrestrial and freshwater
CC	Climate Change (fossil)
EF	Eutrophication freshwater
EM	Eutrophication marine
ET	Eutrophication terrestrial
POF	Photochemical ozone formation
RUEC	Resource use, energy carriers
RUMM	Resource use, mineral and metals
PED	Primary energy demand
BWU	Blue water use

Impact/ Indicator	%Recycled Content									
	10	20	30	40	50	60	70	80	90	100
ATF	-2%	-8%	-14%	-21%	-27%	-32%	-38%	-45%	-51%	-58%
CC	-2%	-8%	-14%	-20%	-26%	-31%	-37%	-42%	-49%	-54%
EF	0%	-3%	-5%	-8%	-11%	-12%	-14%	-17%	-19%	-22%
EM	1%	-4%	-8%	-12%	-16%	-18%	-22%	-26%	-30%	-35%
ET	1%	-3%	-7%	-10%	-14%	-16%	-20%	-24%	-27%	-31%
POF	-4%	-11%	-19%	-26%	-33%	-39%	-47%	-54%	-61%	-69%
RUEC	-9%	-19%	-29%	-39%	-50%	-59%	-70%	-80%	-90%	-101%
RUMM	-5%	-16%	-27%	-38%	-49%	-57%	-68%	-79%	-90%	-101%
PED	-8%	-19%	-29%	-39%	-50%	-60%	-70%	-80%	-91%	-101%
BWU	-3%	-14%	-24%	-34%	-45%	-51%	-62%	-72%	-82%	-93%

² This was in line with what TOTAL expected, given its internal knowledge of the impact generated by styrene monomer, which consumes considerable water and energy in cradle-to-gate production and which is replaced with an EPS stream with far lower impacts associated with its processing.



CONTRIBUTION TO EU POLICIES

- *The project advances in the implementation of the directives called "waste package" (850-851-852 /2018) included in the Plastics Strategy of the European Union and the objective of achieving 10 million tons of recycled plastics by 2030.*
- *It helps to promote regulations governing plastics for food contact, since LIFE EPS SURE would be capable of opening up new markets and laying the foundations for authorisation and the establishment of requirements for EFSA food grade certification for polymers which have not yet been authorised, namely PS.*
- *It contributes to the aims of the Circular Plastics Alliance (CPA) to use 10 million tonnes of recycled plastic for products in Europe. New circular applications are encouraged.*
- *The good practices guide for handling and treating EPS box waste can also be the basis of an environmental certification standard for this purpose.*
- *Life cycle analysis (LCA) shows that saving environmental impacts are the best criteria for legislating on plastics. This fundamental idea has not been taken into account in regulations such as Directive 904/2019, which restricts applications of materials, forcing them to be replaced by others with a greater environmental impact.*



3 CONCLUSION AND SWOT ANALYSIS AT THE END OF THE EPS SURE PROJECT

<p>Strengths</p> <p>100% positive technical results in the decontamination challenge tests and the migration tests, to promote EFSA authorisation at an industrial plant.</p> <p>100% positive mechanical test results for the manufacturing of new r-PS containers demonstrated at the COEXPAN industrial plant.</p> <p>Process with very good environmental credentials, 50% recycled pellets, 50% reduction in energy consumption and CO2 emissions compared with virgin pellets.</p>	<p>Weaknesses</p> <p>Need to improve economic viability of the project, above all in the collection and logistics phase. The lightness and volume of EPS increases costs, and traceability and food origin must be maintained.</p> <p>The TPI PS manufacturing plant in El Prat, Barcelona, closed in 2019 because of the declining market for PS. Building an industrial scale recycling plant would require major investment and the search for a new location, which would probably not be in Spain.</p>
<p>Opportunities</p> <p>Contributes to the Circular Economy by avoiding EPS fish box waste from ending in landfill, where a considerable proportion of such waste is sent in some European countries.</p> <p>Potential for new food contact applications, laying the foundations for new EFSA authorisations for PS.</p> <p>Promote and accelerate systems based on EPR for commercial packaging.</p> <p>Drive fulfilment of plastic packaging recycling objectives: 50% 2025 and 55% 2030</p> <p>Inform stakeholders of the possibilities of EPS recycling.</p>	<p>Threats</p> <p>The unstable and shrinking market for PS (and r-PS) because of reductions and bans established in Single-Use Plastics Directive 2019/904, hampering project cost effectiveness.</p> <p>The positioning of certain stakeholders against plastics, specifically PS and EPS.</p> <p>The high risk in company investment for materials bearing in mind the legislative context.</p> <p>Low landfill taxes in some countries, such as Spain, Italy and Greece and low prices of PS virgin material due to low petrol prices.</p> <p>EFSA authorisations for recycling process are very slow and no criteria existing for PS</p>



With technical liability now demonstrated, the next challenge is to guarantee the economic viability of the process, in particular in the box collection and logistics phase. The management of fish box waste depends on various factors: concentration of reception and distribution points; selective municipal collection, and existence of compacting equipment in areas with significant sales (markets, logistics centres, etc.). The main challenge is to concentrate and compact the waste to optimise transportation and recycling.

Meanwhile, the guarantees required for industrialisation of the process must be ensured, which will demand the implementation of financing systems such as Extended Producer Responsibility (EPR) to make an economic contribution to the process. It will also need to be ensured that regulations do not establish market restrictions that would hamper the required investment, and that the use of recycled material is promoted by increasing landfill levies.

In conclusion, the three years of research under the LIFE EPS SURE Project clearly demonstrate the technical viability of the project. The first step, and one of the most important in order to allow Spain and Europe to recycle EPS fish boxes for high-value-added applications, while furthermore opening up a new market by allowing them to be transformed into r-PS for use in food packaging.

Promotion of these results will continue with the actions instigated through the After-Life Project to boost PS projects capable of benefiting from the results, once market stability and economic conditions are more favourable.



4 AFTER LIFE ACTIONS AND OBJECTIVES

Nº	OBJECTIVE	ACTION	RESPONSIBLE	TIMETABLE/ INDICATOR	BUDGET €
1	Keep the public and other interested organisations and private companies informed about the project, and technical progress in EPS and PS recycling	Keep the web site up-dated with news about the EPS Recycling, new networking, events of the plastic organisations or news about EFSA authorisation http://www.life-eps-sure.com/	CICLOPLAST (Information also will be provided by ANAPE, TOTAL, , COEXPAN and EL CORTE INGLES	2020-2025 Nº of visitors	1.500
2	Keep the public and other interested organisations and private companies informed about the project, and technical progress in EPS and PS recycling	Keep the social networks, twitter and LinkedIn updated with news https://twitter.com/LifeEpsSure	CICLOPLAST AND ANAPE	2020-2025 Nº of tweets and news Nº of followers	2.000
3	Keep the public and other interested organisations and private companies informed about the project, and technical progress in EPS and PS recycling	Proactive distribution of the edited material between the different organisations interested that attended to the Final Info day and EUMEPS members, EPRO members - Layman's Report - Videos, Edited leaflet	CICLOPLAST	2020-2025 Nº of material distributed and people informed	--



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Nº	OBJECTIVE	ACTION	RESPONSIBLE	TIMETABLE/ INDICATOR	BUDGET €
4	Keep the public and other interested organisations and private companies informed about the project, and technical progress in EPS and PS recycling	<p>Keep-on Networking with other PROJECTS related with LIFE EPS SURE</p> <ul style="list-style-type: none"> - LIFE RECIPACK - OCEAN WISE - PS-LOOP - Styrosolution - Polystyvert - Other projects <p>Keep on networking with other organisations</p> <ul style="list-style-type: none"> - Universities - NGO and governments 	CICLOPLAST, ANAPE	<p>2020-2025</p> <p>Nº of networking contacts and results</p>	2.000
5	Promote the EFSA authorisation and criteria for PS recycled into food contact packaging	<p>Keep on Networking with the platform Styrenic Circular Solution</p> <p>http://styrenics-circular-solutions.com/</p> <p>Share information with this platform that is working also in the authorisation of PS recycling for food contact packaging</p> <p>Share criteria used for the challenge test and migration analysis</p>	CICLOPLAST, COEXPAN	<p>Nº of meetings and contacts</p> <p>Summary of results</p>	1.500



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Nº	OBJECTIVE	ACTION	RESPONSIBLE	TIMETABLE/ INDICATOR	BUDGET €
6	Promote the EFSA authorisation and criteria for PS recycled into food contact packaging	Keep on networking with other projects that are asking for the food contact authorisation	CICLOPLAST, COEXPAN, ANAPE	2020-2025 Nº of meetings and contacts Summary of results	1.000
7	Promote the EFSA authorisation and criteria for PS recycled into food contact packaging	Participation in EFSA group about styrenics	ANAPE, COEXPAN	2020-2025 Nº of meetings and contacts Summary of results	1.500
8	Improve the acknowledge of statistics for plastics packaging EPS fish boxes	Modify the Packaging declaration in Ecoembes, including separately EPS packaging, nowadays the EPS packaging is included in the category "other plastics"	CICLOPLAST, ANAPE	2021	-
9	Improve the acknowledge of statistics for plastics packaging EPS fish boxes	Monitoring the EPS packaging declared in Ecoembes by fillers , food packaging and no food packaging	CICLOPLAST, ANAPE	2021-2025	1.500
10	Improve the acknowledge of statistics for plastics	Training with distribution or packaging companies to improve Ecoembes declaration.	CICLOPLAST, ANAPE	2021-2025	1.000



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Nº	OBJECTIVE	ACTION	RESPONSIBLE	TIMETABLE/ INDICATOR	BUDGET €
	packaging EPS fish boxes	The aim is to distinguish between different PS foams and how to declare them			
11	Improve the acknowledge of statistics for plastics packaging EPS fish boxes	Keeping contact with specialized waste managers in industrial and commercial waste streams	CICLOPLAST, ANAPE, EL CORTE INGLÉS	2021-2024	1.500
12	Improve the costs of the collection and logistic of EPS	<p>Optimise EPS collection in El Corte Inglés, a new process for logistic in shops has started in 2020.</p> <p>The clean and empty fish boxes are compacted in every shop by el Corte Ingles personnel and transported in bags from the generation points to an El Corte Inglés Platform, for which the reverse logistics is used (return of the empty trucks to the central platform).</p> <p>Boxes are accumulated until enough is available to fill a trailer.</p> <p>This trailer travels directly to the recycler facilities. It is currently used as an insulating material for construction.</p> <p>In this way, we avoid the waste transporting and storage company for this waste, which</p>	EL CORTE INGLES	<p>2021-2023</p> <p>Reduction of costs</p> <p>T of EPS treated with the new process</p>	



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Nº	OBJECTIVE	ACTION	RESPONSIBLE	TIMETABLE/ INDICATOR	BUDGET €
		<p>represents significant economic savings, and we optimize transport, which means a reduction in the environmental impact.</p> <p>At the moment, the process has been implemented in the El Corte Inglés Shopping Centers in the Galicia Region and will subsequently (following years) be implemented in new regions as the Zero Waste Project progresses. -</p>			
13	Improve the collection and the economic viability of the EPS fish boxes collection and recycling	Promote the EPR system for commercial EPS fish boxes in SPAIN where needed.(SCRAP)	CICLOPLAST, ANAPE	2021-2024	1.000
14	Improve the collection for EPS fish boxes in Ports	Collaborate in audits to ports made by Paisaje Limpio Association, proposing measures to increase and improve waste collection	CICLOPLAST, ANAPE	2021-2022	1.000
15	Improve EPS fish boxes collection in big fish markets and supermarkets reverse logistics points of	Keep the staff updated about EPS special compaction equipment and maintain networking with logistics and compaction companies	CICLOPLAST, ANAPE	2021-2025	1.500