LIFE CIRC-ELV

BOOSTING CIRCULAR ECONOMY OF PLASTICS FROM END-OF-LIFE VEHICLES THROUGH RECYCLING INTO HIGH ADDED-VALUE APPLICATIONS

Deliverable D_A1.3.

Deliverable Name: Requirements for the ELV plastics management model

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Dissemination level		
PU	Public	✓
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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1. Summary and Objectives

LIFE CIRC-ELV project aims to develop a new management model for End-of-Life Vehicles. This model is focussed on increasing the recovery ratio and the quality of the plastics that are present in ELVs, before they are sent to shredding plants. Thus, a new business model arises for recycled plastics from ELVs which is intended to be techno-economic and environmentally sustainable.

This deliverable is intended to provide guidance for successful implementation of the project based on consultation of stakeholders in the ELV management and plastics recycling value chains. It will involve the collection of first-hand information to analyse the barriers and opportunities for the solution proposed in the project. A key aspect of this task will be to determine the technical, quality and economic requirements by the end-use industries to use recycled plastics in their products. In addition, opportunities to include recycled plastics in product standards will be analysed.

2. Methodology for getting feedback from stakeholders

In order to obtain the information from the stakeholders, a survey was prepared[1]. The survey aim was to collect information from a range of stakeholders, such as ATFs, shredding operators, waste managers, plastic recyclers, end-use industries, sectorial organisations, policymakers, academia, etc. The information collected encompasses techno-economic, socio-cultural, regulatory and environmental aspects relevant for the project. All partners worked in the preparation of the survey template and in defining the type of stakeholders and methodology for collecting the information.

When working on the questions to include in the survey, we determined that there were some questions that could be addressed to any person/entity but that there were other questions that could only be addressed to a specific type of stakeholder. After analysing the questions to be raised to the different stakeholders we agreed that the questionnaire would have:

- 8 questions to define the entity
- 9 questions common for all stakeholders
- 4 specific questions for Public administrations
- 6 specific questions for manufacturers of products
- 3 specific questions for ATFs
- 4 specific questions for Shredders
- 3 specific questions for recyclers/compounders

[1] Questions are available on-line: https://lifecircelv.eu/survey.php

After having defined the questions for the survey, AIMPLAS looked for the most efficient way for making the survey available to the different stakeholders in order to obtain as much feedback as possible. The decision was to include the survey in an electronic format into the project website and then contact via mail as many stakeholders as possible inviting them to fulfil the survey.

All partners got involved in finding the different stakeholders to be contacted. Finally, 90 stakeholders received a personal e-mail asking them to fill-in the survey (see Annex 1 for details).

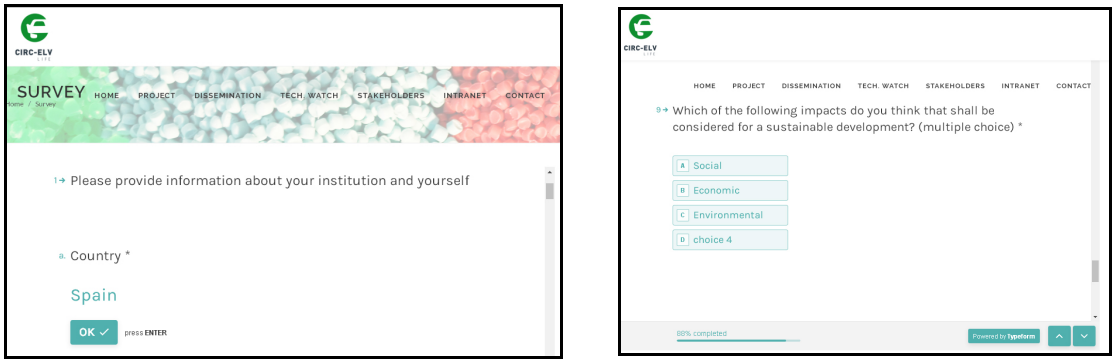

Figure 1. Survey included in the project website

In addition to this direct action, several partners included a communication on their social networks inviting anyone to fill-in the survey.

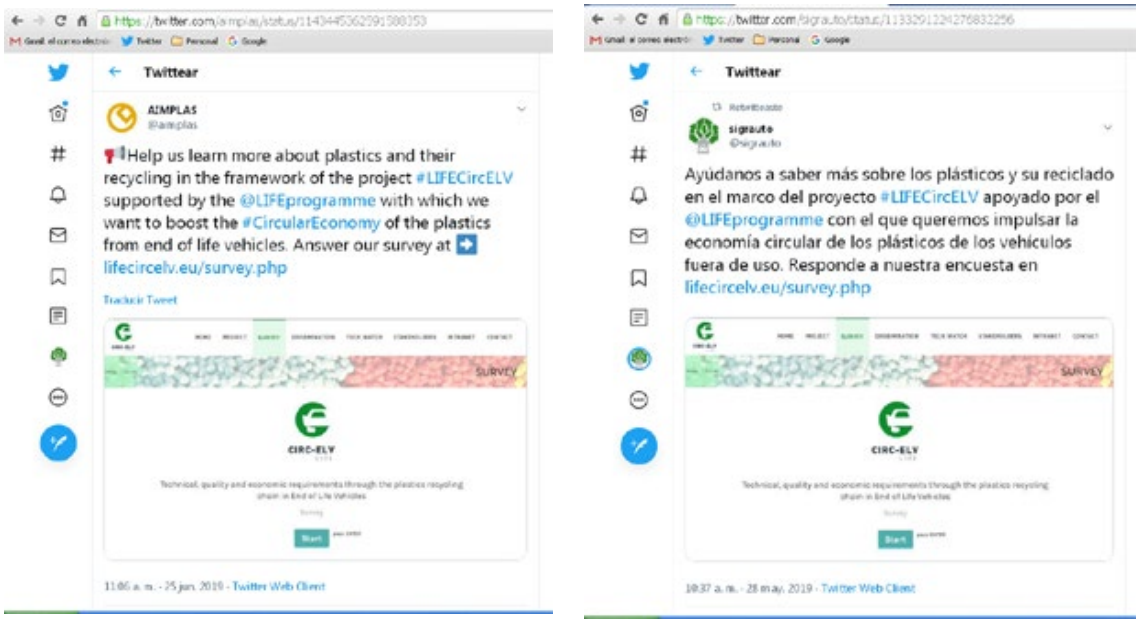

Figure 2. Survey communication in Social Networks

3. Survey Results

The survey was finally answered by 50 stakeholders[2]. Even if the total number of answers is not too high, it is important to point out that some of the stakeholders that have answered it are very relevant and even they represent much more than just a single company/entity.

3.1.Stakeholders profile

The following figures will show the profile of the stakeholders that have answered the survey. We believe that they could be considered as a good sample because there are stakeholders of all different types and well balanced in size.

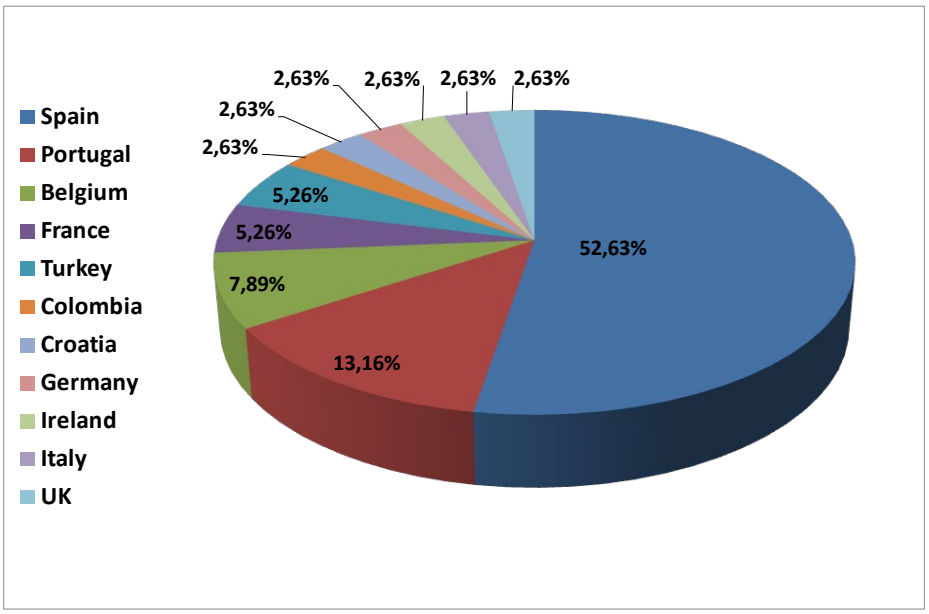

Figure 3. Country of the stakeholders that answered the survey

[2] Records can be found here:

https://docs.google.com/spreadsheets/d/1Ex2aSJmtjgnsYPeFT4zDv68KywiexUUnlFfj9FL_lul/edit?ts=5cf0d9fe#gid=890240269

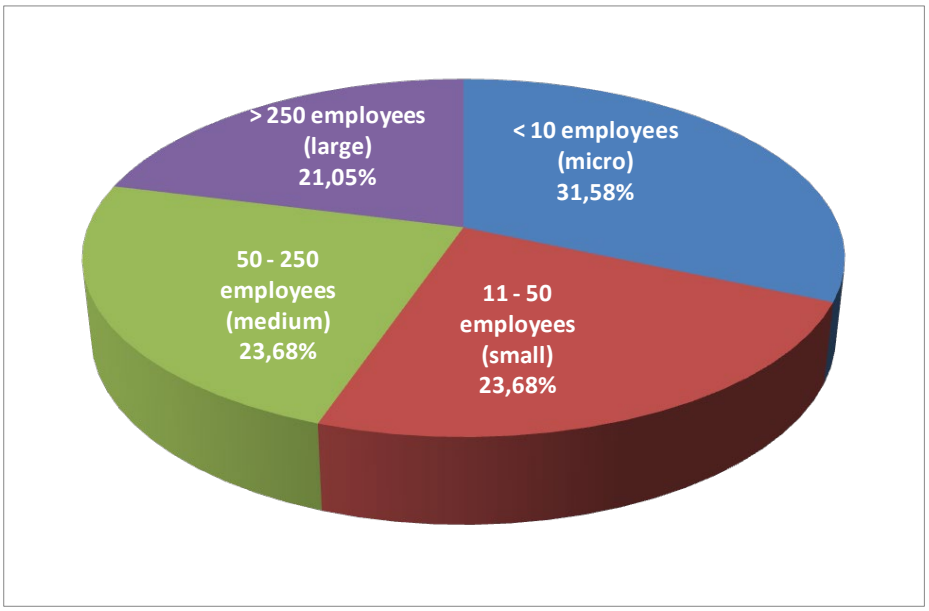

Figure 4. Size of the entity

It is also important to comment that more about 30% of the stakeholders that answered the survey have the ISO 140001 standard certification.

The country with more stakeholders having participated is Spain representing around half of the total stakeholders, but it is important to see that there are answers coming from many different countries in Europe giving a wider scope.

3.2. General aspects of recycled plastics

The following figures will show the results of the survey with regard general aspects regarding recycled plastics. It is important to point out that the survey indicated that these questions had to be answered "*Based on your own experience / opinion…*"

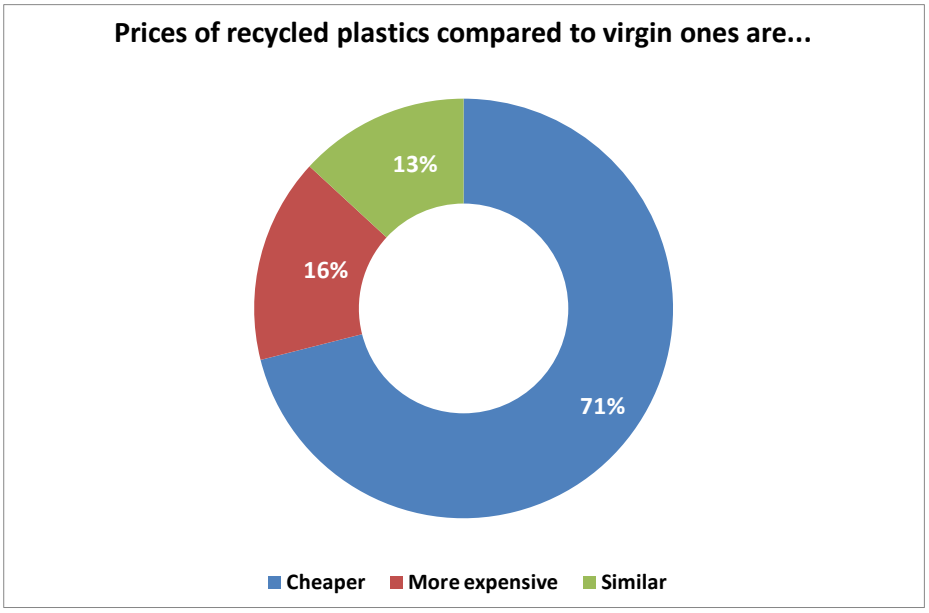

Figure 5. Price of recycled plastics

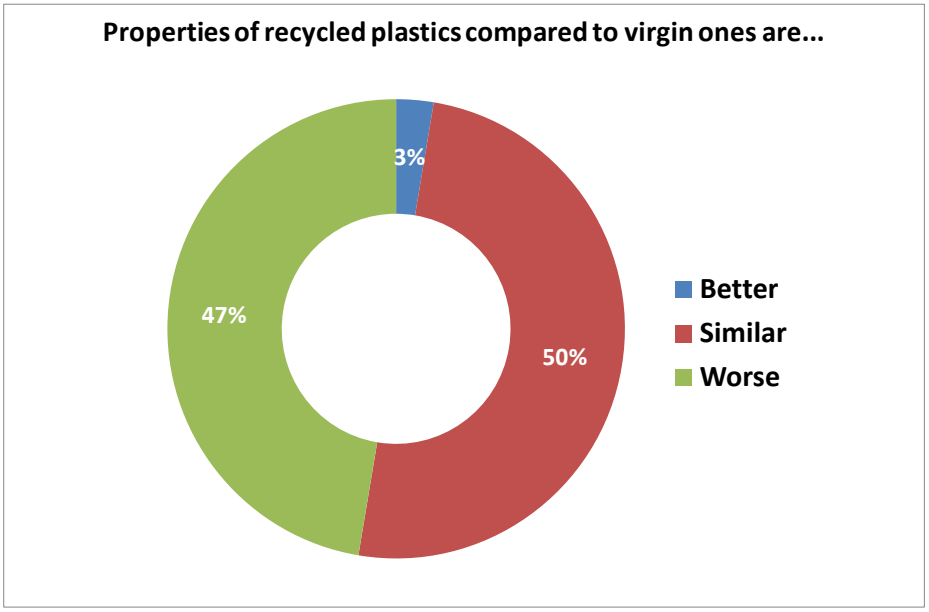

Figure 4. Properties of recycled plastics

When asked about comparing the price and the properties of recycled plastics comparing them with virgin ones, most stakeholders have indicated that recycled plastics are cheaper (71%) but that their properties are Worse (47%) or similar (50%) being very few the ones indicating that are better.

The interesting thing is that, even when they indicated that the recycled plastics have generally worse properties than virgin ones, when asked about their readiness to buy products made from recycled plastics the results are the following:

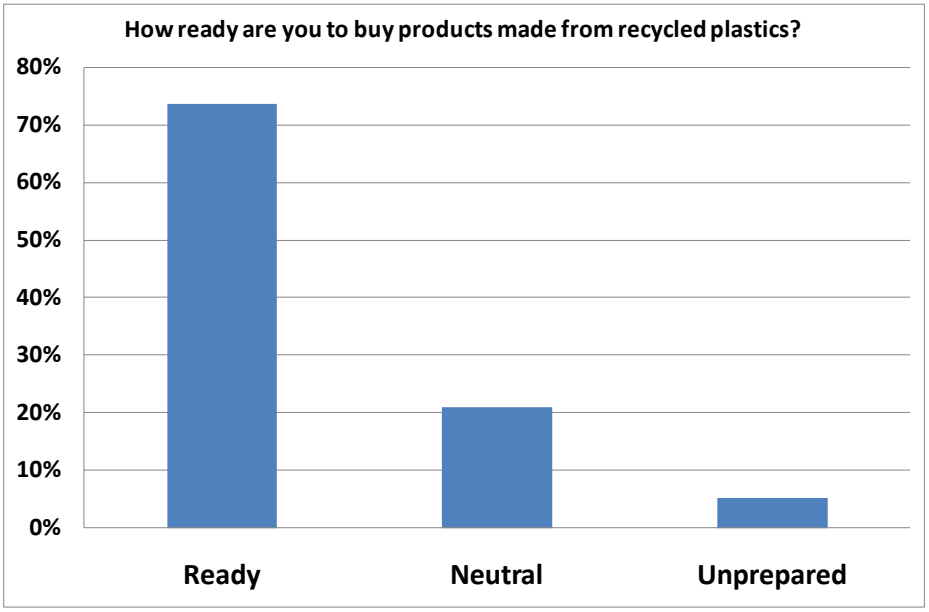

Figure 5. Ready to buy products made of recycled plastics

And if they are asked if recycling plastics and using recycled plastics instead of virgin ones is or not environmentally friendly the answer is almost unanimous.

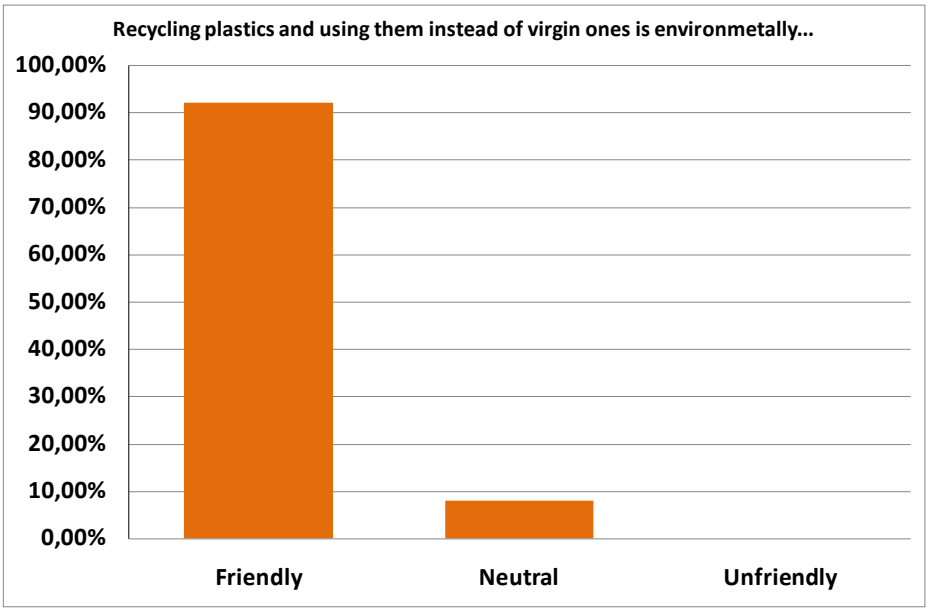

Figure 6. Is recycling plastic environmentally friendly?

Thus, it could be said that people are mostly ready to buy products made of recycled plastics and consider that recycled plastics are environmentally friendly, have similar or worse properties and are cheaper than virgin ones.

3.3.Aspects related to ELV treatment

When asked about the regulatory framework for End of life Vehicles (ELVs) about 74% of the stakeholders know that there is a Directive that regulates the treatment of ELVs and from those 71% know that the regulation sets targets of recovery and recycling.

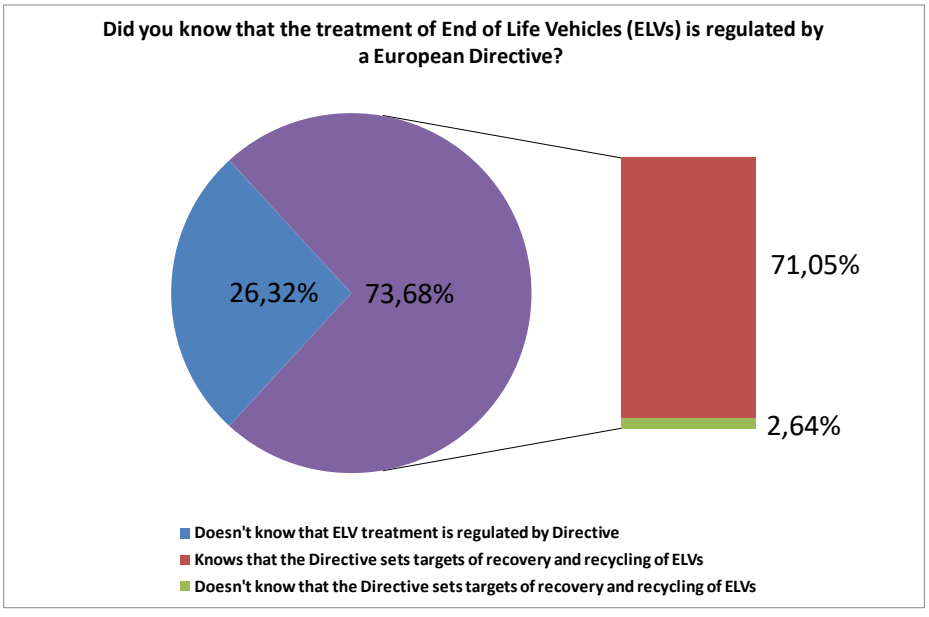

Figure 7. Awareness on the regulation on ELVs that sets targets of recovery and recycling

The following question was about the main difficulties when trying to recycle plastics from ELVs and it was possible to give several answers. The following figure shows the answers received and almost half of the stakeholders have indicated that the main difficulty is that vehicles contain many different types and plastic compositions.

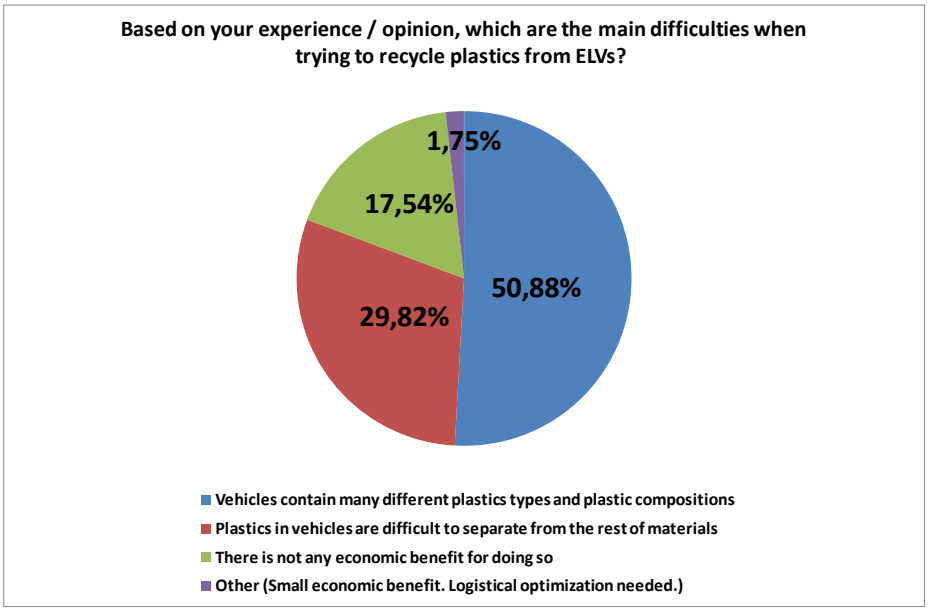

Figure 8. Awareness on the regulation on ELVs that sets targets of recovery and recycling

When asked if they would be in favour of increasing the amounts of recycled plastics in new products the stakeholders indicated that they were completely in favour.

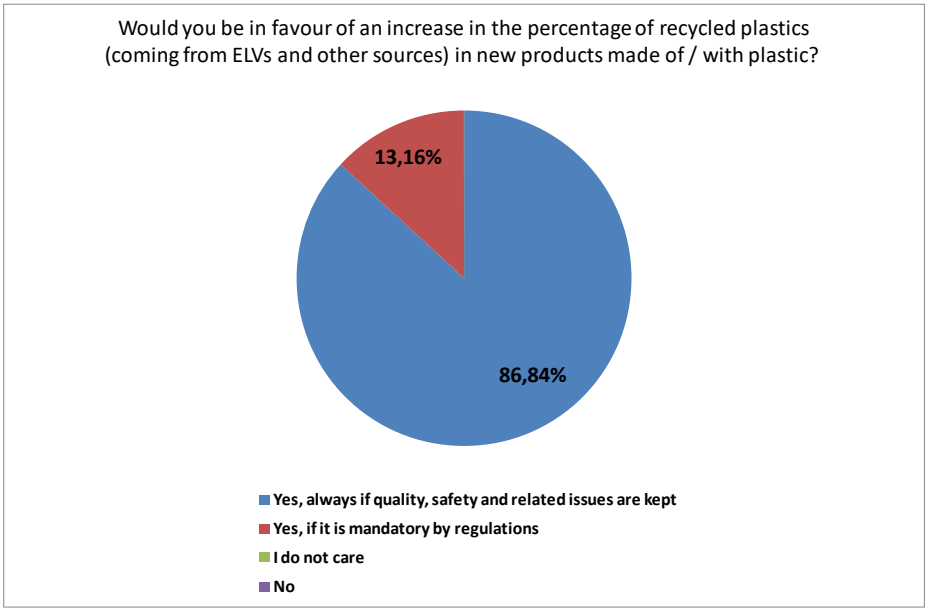

Figure 9. Awareness on the regulation on ELVs that sets targets of recovery and recycling

The last question addressed to all types of stakeholders was which impacts they thought involve a sustainable development. It is important to point out that it was a multiple-choice question so the stakeholders could indicate more than one of the impacts and the results show that they have indicated a little more environmental impact followed closely by economic and also social.

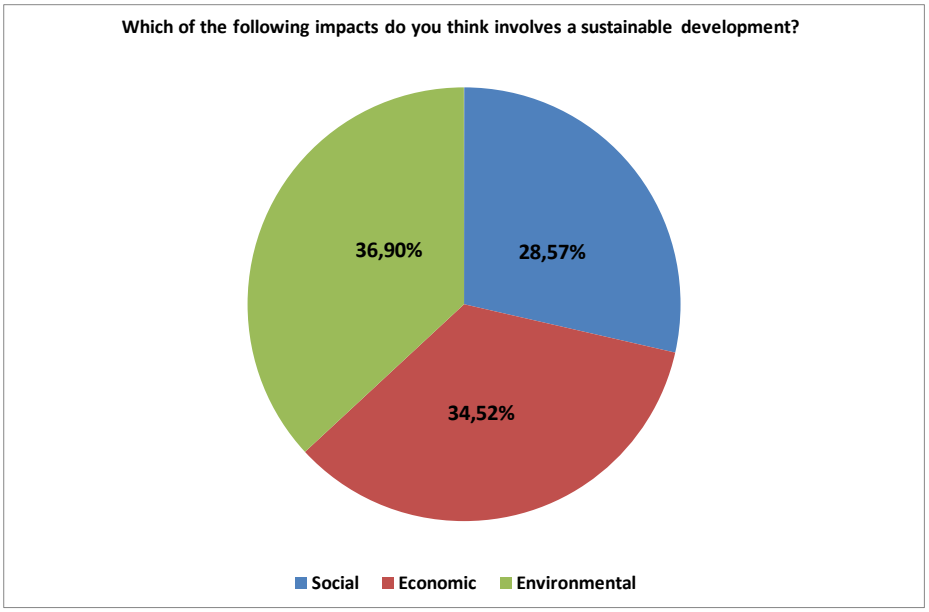

Figure 10. Awareness on the regulation on ELVs that sets targets of recovery and recycling

From here the survey addressed specific questions to the different type of stakeholders as explained before.

3.4. Specific questions for Public Administrations

The survey asked public administrations if they had any financial help for ATFs and all of them declared they don't have any financial help for them.

Then the survey asked them if they were acquiring or promoting products made of or with recycled plastics and they all said they did except for one that was a municipality.

Only one of the public administrations indicated that they were enrolled in developing / reviewing / updating any law or regulation related to the management of End of Life Vehicles (ELVs).

3.5. Specific questions for Manufaturers

80% of the manufacturers answering the survey were using recycled plastics in their products to some extent.

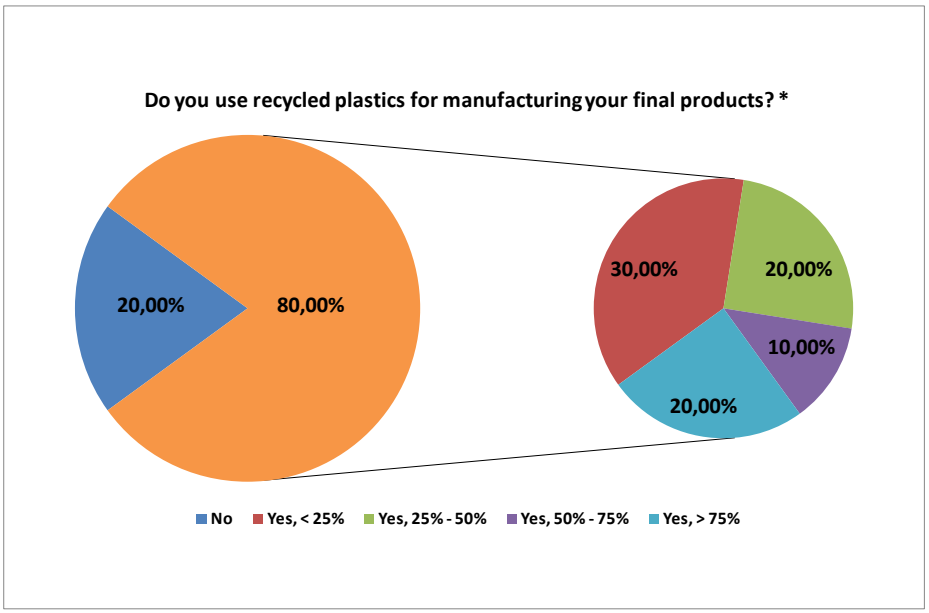

Figure 11. Use of recycled plastics for manufacturing their final products

When asked about the barriers they find for distributing and selling their products made of or with recycled plastics all manufacturers have indicated that there are no barriers and that these products are sold as others.

They are sold as others do	100,00%
These products are better sold than non-recycled ones	0,00%
There is slight unacceptance (aesthetical or others)	0,00%
Otrher	0,00%
TOTAL	100,00%

Figure 12. Barriers when distributing products made of or with recycled plastics

Then the survey asked them to indicate their main reasons for making products of or with recycled plastics.

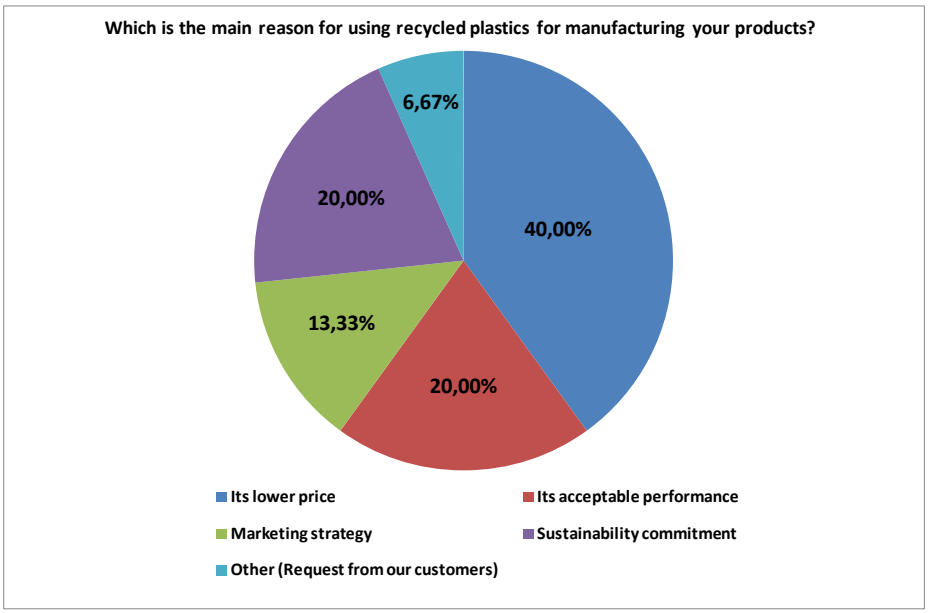

Figure 13. Reasons for using recycled plastics in their final products

The following question was regarding their plans with respect the use of recycled plastics in their products if the quality of the feedstock is enhanced.

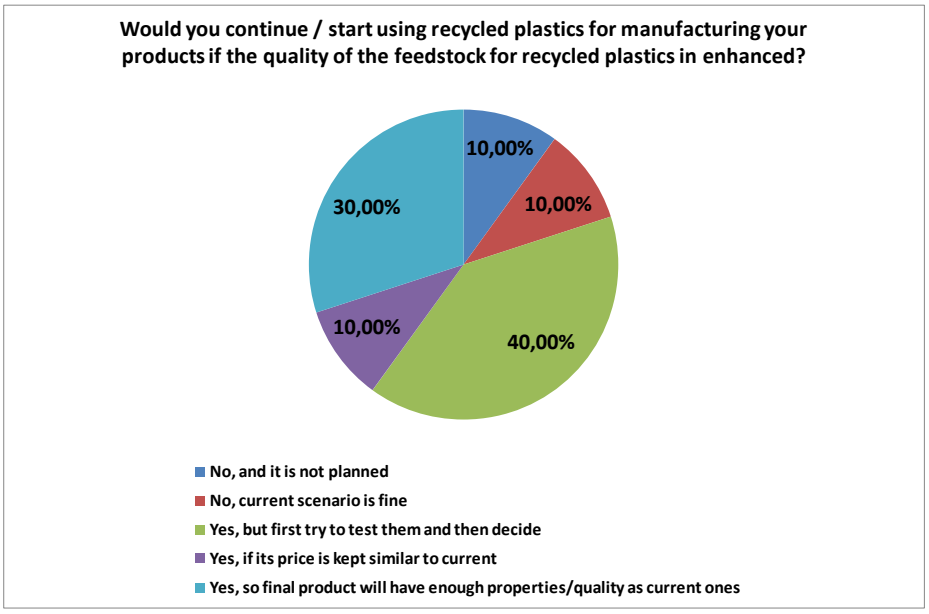

Figure 14. Plans for using recycled plastics if quality is enhanced

When asked about the decision making of fabricating a new product the manufacturers indicated that:

We make products focused on their reuse and refurbishment, better than they are made of / with recycled materials.	50,00%
We make products focused on they are made of / with recycled materials, better than for reusing and refurbishment.	10,00%
We use recycled materials for manufacturing products as they have been designed for their reuse and refurbishment.	40,00%
TOTAL	100,00%

Figure 15. Decision making when manufacturing a new product

3.6.Specific questions for ATFs

Only one ATF answered the survey, so there is not any statistical information that can be provided as it is not representative.

3.7.Specific questions for Shredders

Only one Shredder answered the survey, so there is not any statistical information that can be provided as it is not representative.

3.8.Specific questions for Recyclers/Compounders

The first question that recyclers/compounders had to answer was if their products had to fulfil any technical requirement. All recyclers and compounders indicated that their products need to fulfil technical requirements. Then the following question was:

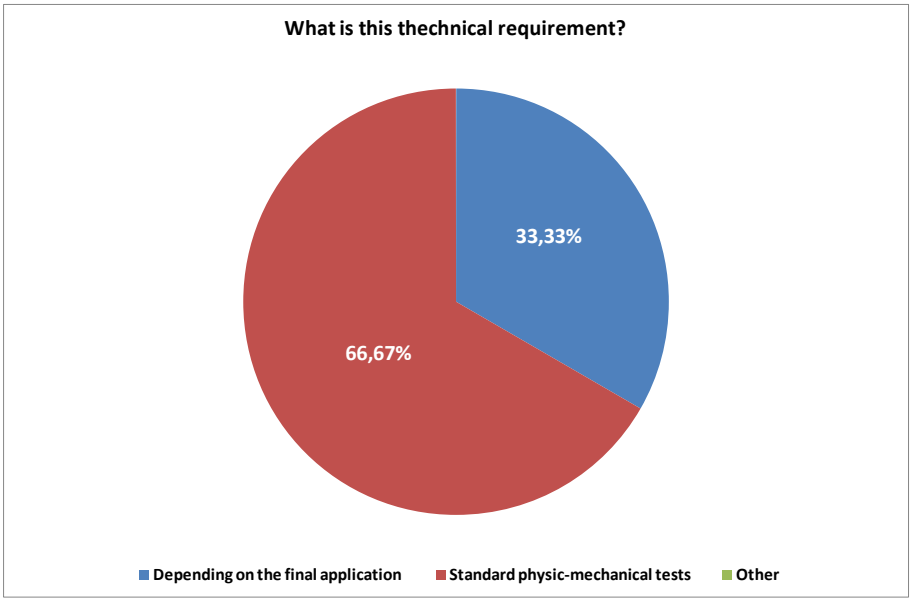

Figure 16. Technical requirements for recycled products

All recyclers/compounders indicated that the product they commercialise needs to fulfil aesthetical requirements. Then the following question was:

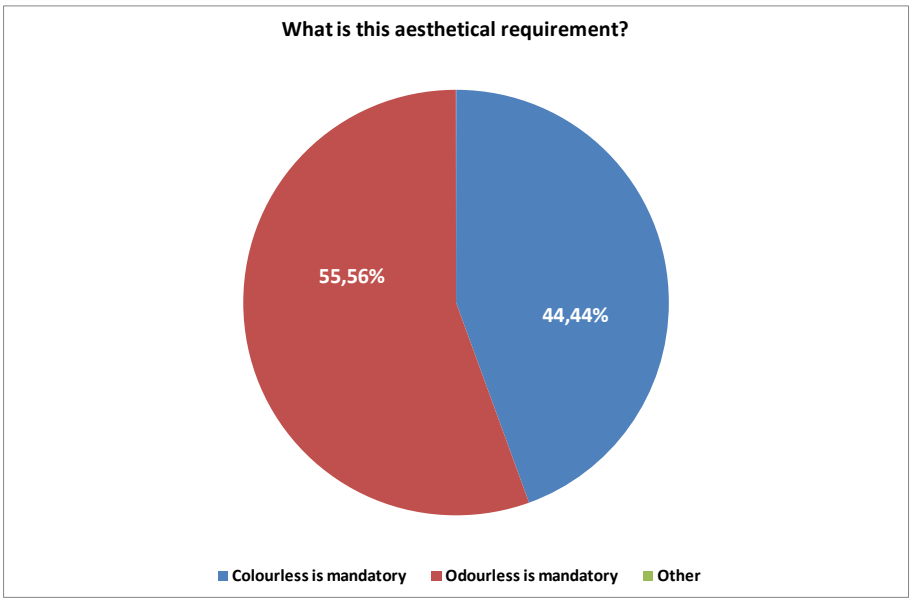

Figure 17. Aesthetical requirements for recycled products

Then the survey asked them if they used recycled plastics.

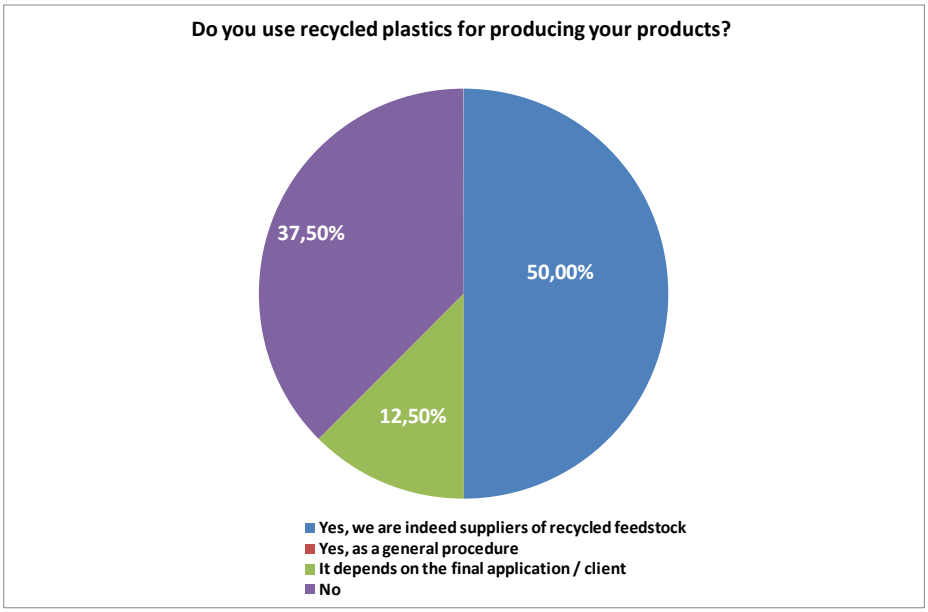

Figure 19. Use of recycled plastics when producing their products

4. Survey Conclusions

The main conclusions that have been obtained from the survey and that will be considered during the project are:

- People are ready to buy products made of or with recycled plastics even if they consider that their properties are slightly worse than virgin plastics.
- There is a good knowledge regarding that regulation on End of Life Vehicles

- The main difficulties when trying to recycle plastics from ELVs are that vehicles contain many different plastics and that it is difficult to separate from the rest of materials.
- Manufacturers (at least the ones that have answered the survey) are using recycled plastic in their products mainly because their lower price and because there are no barriers when selling those products.
- Recycled plastics need to fulfil technical and aesthetical requirements that are basically standard physic-mechanical tests and odourless and colourless characteristics.

From our point of view the information obtained indicates that there is a real possibility of recycling plastics coming from ELVs because the market is ready and it is more a matter of doing a good sorting of plastics in order to obtain a high quality material.

5. Techno-economic and quality requirements for selected products and sectors

As for the results on the survey performed to different actors in the whole value chain of ELV plastics and focussed on those potentially dealing with recycled plastics (converters), many aesthetical and mechanical properties shall be fulfilled for them to be used.

In that sense, a review of different sectors where recovered PP or HDPE would be used follows, indicating the values for the virgin materials, including critical parameters. For instance, immiscibility is important issue to take in account, because due to expensive cost of separation of recycled plastics, it is desirable to use recycled plastic blended. But this has a problem in processability caused by the difference in melting point some materials suffer degradation and the lack of compatibility between the polymers, both reduces the quality of the product.

For these reasons, to achieve similar properties than virgin plastic with recycled plastics, is necessary to additive them with stabilizers and compatibilizers to protect against polymer degradation and ensure compatibility between blends.

In addition, economic has a great weight on the selection of a recycled material, as the results of the survey showed.

5.1. Overall technical requirements

The excellence of the injection products depends of the compound's quality and their good conditions processed. If it is a recycled material, it should consider three main characteristics to achieve it:

- First of all, if the recycled material is a blend of different polymers, they had to have a similar nature or chemical composition, thus these materials have similar melt temperature and it is reduced possible defects such as infused or degraded by temperature and shear.
- Also, compounds should have a homogeneous size with the finality that materials spend the same time to melt and consequently reduce defects in the sample.
- Polymers for injection process is recommended that they have a melt flow index (MFI) higher than for extrusion process. Specifically, HDPE and PP shall vary between the following values

Table 1. MFI values

Polymer	Testing conditions	MFI (gr/10 min)
HDPE	190ºC & 2,16 Kg	4 - 25
PP	230ºC & 2,16 Kg	5 - 100

5.2. Economic trends

If the price of virgin HDPE is analysed, it can be concluded that in the last year its price has been decreasing in a 14,94%.

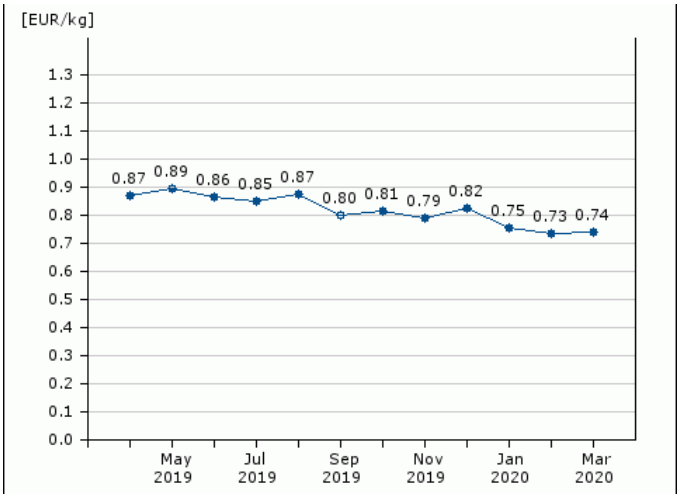

Figure 1. Price development of PE-HD (12 moth). Source: Plastiker

However, for the virgin PP, the prices development is most constant than HDPE. Practically it is present the same cost than a year ago.

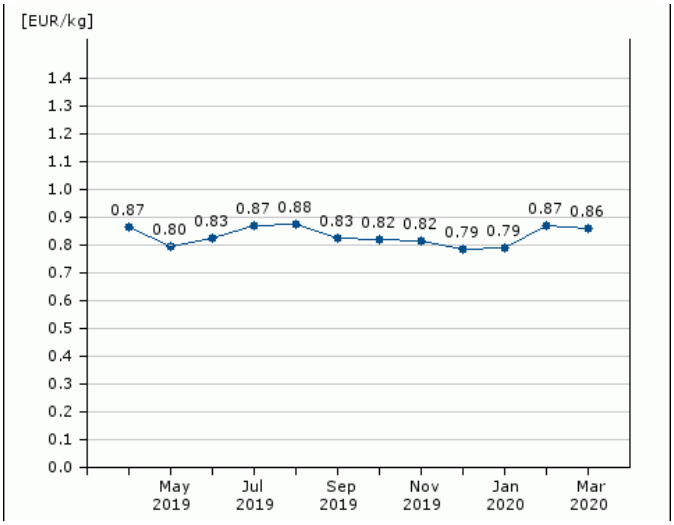

Figure 2. Price development of PP (12 moth). Source: Plastiker

On the other hand, in terms of recycle material, both have the same price which are lower than virgin ones. For HDPE are an 8% less and for PP until an 22% lower.

Table 2. Comparative prices for recycled and virgin selected polymers

Material	Recycled (€/kg)	Virgin (€/kg)
PP	0.67	0.86
HDPE	0.68	0.74

5.3. Selected sectors and products

Polypropylene and high-density polyethylene are used in many applications, and requirements may differ.

5.3.1. Automotive sector

PP is by far the most used plastic in automotive sector if we look on relative amounts in databases like IDIS, or other reports like the Deliverable D_A_1.2 from LIFE CIRC-ELV project.

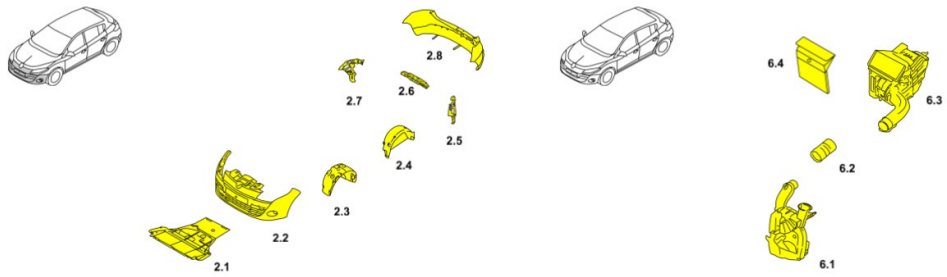

Figure 3. PP plastic parts in a vehicle

This material is mainly used because of its impact resistance, being always mixed with EPDM or other thermoplastic elastomers / copolymers. For that reason, bumpers are made of this (mixed) material. Beyond bumpers, other external parts are made of this PP+EPDM material such as wheel liners belong to these parts. Homologation of a material is based on the performance when it is converted into a final piece. Changing the materials is not straightforward, but minimal properties shall be fulfilled for doing so.

In that sense, for the reference material used for wheel liners and bumpers. For instance, in SIGIT, plastics meet the following tests to be able to use them in automotive sector and thus will be able to homologous them, based on Esp. TL526 49 (2088 01 01) MD05.

Table 3. Plastic's properties for automotive sector

Test	Standard
Melting Temperature	ISO3146
Density	DIN53479

Hardness	DIN53505 Shore D (Radspoiler)
Impact strength un/notched	ISO179
Ball drop impact strength	PV3905
Thermal ageing	200h a 150ºC

Specifically, in these materials the MFI based on ISO-1133 is about 8-10g/10 min, which achieve the specifications of clients 7-13 g/10 min.

Also, the materials should be analysed through TGA (PV 3927) and DSC (ISO11357) based on Esp. VW50123 (2015 09).

Regarding the price, for instance, the cost of bumper materials is between 1.05-1.16 €/kg and to wheel liners 1.04-1.095 €/kg, the recycling material had to have similar prises to be competitive.

5.3.2. PIPES (Agriculture or construction)

In the corrugated plastic pipe industry has been using post-consumer recycled HDPE many years ago. Also, recycled material can only be used in gravity flow applications which is non-pressure pipe such as drainage, culvert pipe, turf drainage and underground retention/detection.

National standards of materials ASTM F2306 for corrugated HDPE pipe reflects the allowance for virgin and/or recycled resin content, as long as the compound achieves the Un-notched Constant Ligament stress (UCLS).

Figure 4. HDPE Pipes

Moreover, pipe fitting that are produce by injection moulding are available in recycled HDPE, which are used in drainage, stormwater systems, culverts, crossings, on-farm water management, irrigation systems…These products are in accordance with AS/NZS 1462.22:1997, with it, demonstrated that they has similar stiffness/load ratings to PVC pipes of similar dimensions.

Figure 5. HDPE Fittings (The Green Pipe Sydney)

In pipe fitting are common requirements high flow and medium impact strength, in the following table are seen typical material characteristics for this application.

Table 4. Plastic fitting pipe properties

Property	Test Method	Value
Melt Flow Rate (230º/2.16 kg)	ASTM D1238	38 g/10 min
Tensile strength at yield (50 mm/min)	ASTM D638	26 MPa
Elongation at yield (50 mm/min)	ASTM D638	7 %
Flexural modulus (1% secant)	ASTM D790A	1150 MPa
Notched Izod impact strength (23ºC)	ASTM D256	70 J/m
Heat Deflection Temperature (455 kPa)	ASTM D648	105ºC

5.3.3. Packaging

Bottles for oil and containers for IBC (intermediate bulk containers). These products should have obeyed the following laws in terms of packaging-transport packages for dangerous goods UNE EN ISO 16495, ISO 16106 and Spanish Royal Decree 97/2014.

Figure 6. Internal Bulk container

5.3.4. Furniture

Urban furniture can be produced by WPC (Wood plastic composite) with any recycled plastic which can melt and be processed below the degradation temperature of wood fillers (200ºC) or with plastic lumber.

In general, recycled plastics increase in melt flow index respect to virgin plastics, these improves the impregnation of plastic with fillers.

Figure 7. Examples of WPC structures

5.3.5. Pallets

It can produce industrial pallets with HDPE and PP recycled. Contrary to wooden pallets, which must be retired of circulation after a tiny number of rotations, plastic pallets can be used countless times. If it has a properly maintained, recycled plastic pallets are incredible strong and durable lasting in exceeding of 10 years.

Figure 8. Pallet made of recycled plastics

5.3.6. Appliances / Houseware

The three major types of plastics that are found in home appliances are polypropylene (PP), polystyrene (PS) and acrylonitrile-butadiene-styrene (ABS).

Some important companies in this sector like Mitsubishi electric and Electrolux has investigated an promoted the use of recycled plastics until 50-70 % and recyclable plastics about 90% in their products for instance of refrigerators, washing machines and vacuum cleaners.

Figure 9. Vacuum cleaner containing recycled plastic parts

Annex 1 – Contacted institutions invited to fill in the survey

Nº	Acronym	Nº	Acronym
1	VALORCAR	46	CTC
2	FEBELAUTO	47	CESPA
3	ELVES	48	COGAMI
4	MI-PLAST	49	CORDOPLAS
5	ACTECO	50	ESLAVA PLÁSTICOS
6	BORNOVA	51	GRANZAS ALSER
7	OVAM	52	LAJO Y RODRÍGUEZ
8	CMPLASTIK	53	NATUR CYCLE PLUS
9	CAMARA	54	PLÁSTICOS ALSER
10	CICLOPLAST	55	S. SOLIS
11	MCHT	56	SAICA
12	IYTE	57	SINTAC
13	ACR+	58	SOLTECO
14	ANAIP	59	DESGUACES PENICHET
15	ANIACAM	60	ANARPLA
16	SEAT	61	AVEP
17	CONAMA	62	ALZIRA
18	SSSUP	63	DIPUTACIÓN DE VALENCIA
19	ANFAC	64	LAS NAVES
20	ADECOVA	65	KOPRIVNICA
21	IBER RESINAS	66	MANCOMUNITAT RIBERA ALTA
22	ZORTON PLASTICO	67	CALAF
23	ALMENAR	68	ZICLA
24	GVA	69	ALQUIENVAS
25	VAERSA	70	GALLOO PLASTICS
26	HENSEL RECYCLING	71	AXION
27	GRUPO TRAGSA	72	BAQUELITE LIZ
28	ÖCAR	73	JSL
29	ABN	74	AUTOGRUAS SANT JORDI
30	REPSOL	75	NEUTROPLAST
31	SCHOLTZ	76	AUTODESGUACE OTONIEL
32	WIPAG	77	DELFINCARD
33	CALLPARTS	78	RECICLAUTO
34	GALEA POLYMERS	79	DESGUACES EL CHOQUE
35	TRANS SABATER	80	MTES
36	GRUPO GW PLASTICS	81	ADEME
37	CITSALP	82	MPSA
38	ASP	83	RENAULT
39	CEP	84	SYNOVA
40	APA	85	AXION
41	SICOR	86	ARN
42	AEDRA	88	FERIMET
43	FER	89	GLOBAL PARIS
44	ECOGLOBAL	90	ICRM
45	GIRSA		