LIFE CIRC-ELV

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

Deliverable D_B5.4.

Deliverable Name: Techno-economic analysis report

Version Number: 1

Lead Beneficiary: DESGUACES CORTÉS

Grant Agreement nº: **LIFE17 ENV/ES/000438**

Start Date/Duration: September 2018 / 44 Months

Due date: Month 3 → updated January 2022 (M42)

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

This deliverable aims to explain the techno-economic analysis of the processes carried out during the project. The analysis has been done firstly by analysing the main technical parameters that affect the viability of the solution to be adopted. Then the same analysis from an economic perspective has been performed to finally obtain a techno-economic analysis.

2. Technical analysis

During the project, the consortium has had to deal with many technical issues that needed to be studied to find the best solutions in the different stages.

2.1. Extraction of the bumpers

The process to extract the bumpers needs to be optimized for the specific conditions of the ATF where the operation is carried out. The methods to be used can vary:

- complete manual extraction with standard tools
- manual extraction with specific bumper extraction tools
- use of the forklift for detaching the bumper from the vehicles
- use of the grapple in the press
- use of specific grapple for removing and cutting parts from ELVs

All these different methods give different efficiencies leading to different costs so that each ATF need to evaluate if it is interesting to acquire specific equipment to optimize the process of extracting the bumpers from the vehicles depending on the volume of vehicles they treat.

2.2. Preparation of the bumpers

After the extraction, specially when it has been done with destructive methods, bumpers need to be “cleaned” from all materials that are not PP made or compatible with the PP recycling process. These operations need to be done manually, but in the quickest and more effective way. The use of pneumatic tools can be useful for extracting some of the parts that sometimes are attached to the bumpers like fog lights, sensors, etc. When possible, it is better to use more destructive separation methods, like hammers, saws, etc.

It is also recommended to have specific tools for these operations so that the worker can easily remove all these materials and store them separately for their recovery. This can lead to a high reduction of time and costs for the ATF.

2.3. Transportation of the bumpers

Once the bumpers have been extracted and “cleaned” they need to be transported to the recycler or the compounder, depending on the different possibilities of the different actors involved and specially if they have a washing process for eliminating the dirt and dust of the materials.

For the transport operation the ATF has different options:

- Send the bumpers with no size reduction.
- Acquire a baling machine to bale several bumpers and reduce volume.
- Acquire a shredding machine to get higher volume reduction.
- Acquire a shredding machine plus a washing unit.

Again, the decision to opt for one or other solution depends on different factors, mainly linked with the number of ELVs treated by the ATF. Recyclers prefer to receive the bumpers just baled, so that they can evaluate the materials before their shredding and avoid any impurities. This can be a decisive factor when making any investment decision on possible size reduction machinery.

2.4. Preparation of the chips of PP

Compounding companies need to receive the PP, usually in chips, with a specific maximum size and washed. Depending on the compounding company, the recycling company that providing the materials may need to shred and wash the materials to comply with the requirements set by the compounding company.

2.5. Compounding phase

The compounding company may need to carry out different tests to find the best formulation for the PP entering their facilities. This formulation depends on the final client and the product that is going to be produced with the material. In the compounding process the compounding company may need to make sure that the pellets obtained comply with the requirements of the final client. The different additives used by the compounding company can affect different properties of the final product like stiffness, flow module, odour, etc.

It is also very important to establish the percentage of recycled material to be used in the final material. Depending on the final application these percentages can vary from 100% recycled material to 0%. When aiming to high quality final products it is difficult to have very high percentages of recycled material. During the project, several batches were produced to find the highest percentage of recycled material to be used. It was found that, for the applications selected, the levels of recycled material should be in the surroundings of 25% .

2.6. Production of the final products

The companies producing the automotive parts or the pipes, by using the recycled materials, need to make sure that the final products obtained meet all the standards and fulfil all the quality tests required for their products. At the same time, they need to make sure that the injection machines are not affected in a negative way due to the use of the recycled content.

2.7. Conclusions of the technical analysis

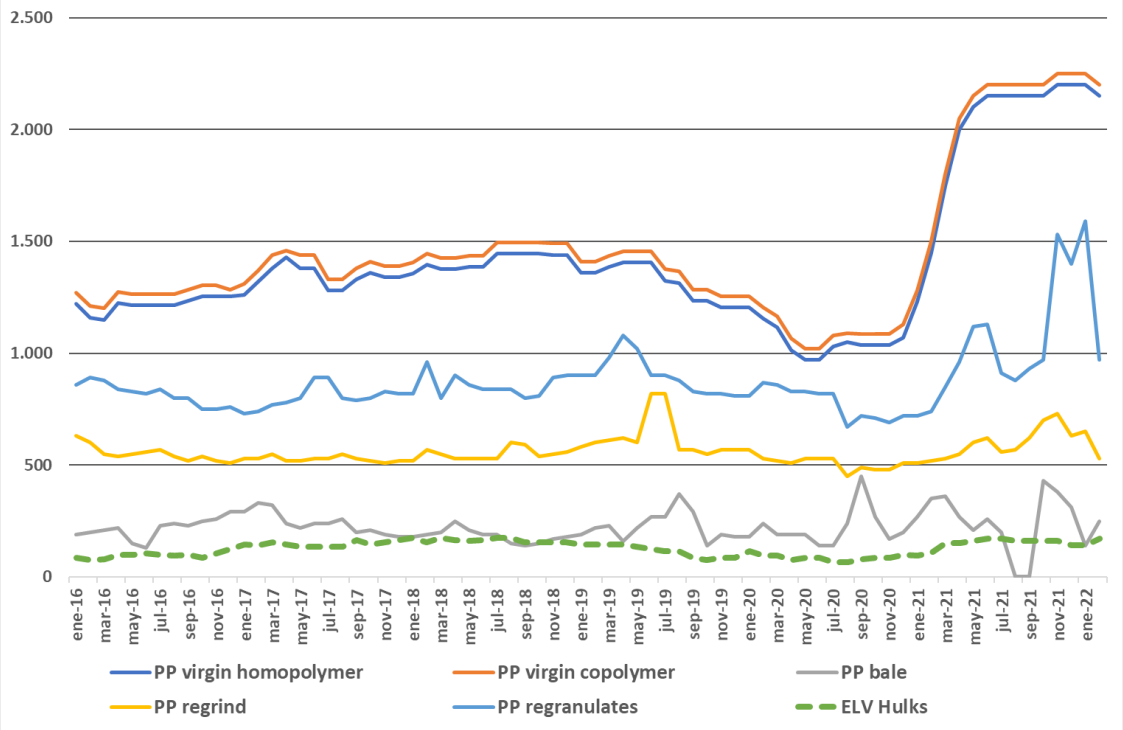
Regarding the technical analysis, the following can be concluded:

- Recycling PP from bumpers, obtained from end-of-life vehicles, is technically viable.
- There are different technical aspects to consider in the different phases of the process that are affected by different conditions.
- The final application sets most of the technical requirements in the whole process because determines the parameters needed for the pellets obtained from the compounding company and this affects to the quality of the processes at the recycler and the ATF phase.

3. Economic analysis

When analysing the economic viability of recycling bumpers obtained from end-of-life vehicles, there are also many parameters to take into account.

The main aspect to be considered is if the value of the materials extracted from the ATF could represent a profitable activity or not. This depends on the price of the plastics obtained, but also on the value loosed for not leaving the plastics in the body hulk sent to the shredding facilities, obtaining a price for each kilo of material. The following graph shows the evolution of these prices in €/ton during the last years:



PP baled has usually a positive gap when comparing with ELV hulks, but this is not a big difference, with an average of around 100 €/ton. PP regrind has a bigger gap of around 450 €/ton and the PP regranulates have a gap of around 750 €/ton. As already stated in the technical analysis, one of the problems ATFs could have is that the recycling facility may not be willing to accept regrinded bumpers. This means that they can send them whole or baled with only 100 €/ton margin.

At this point, it is also important to consider the transportation costs of this kind of materials with low density, even if the bumpers are baled. This kind of materials cannot be transported long distances, so it is important that the recycling plant is near the ATF. It is also important to maximize the weight sent in each transport i.e. a full truck should be used because sending few hundreds of kilos of this material may have an extra cost, consuming possible benefits.

In this context, the different initiatives led by the European Commission, but also around the globe, aiming to a more circular economy and specially trying to solve the problems derived from the low levels of plastics recycling could play a significant role in the future evolution of the markets and on the prices. As shown on the graph, the prices of both virgin and recycled plastics have reached unprecedent values in the last months of 2021 and the beginning of 2022, as most of the raw materials, due to different market situations caused by not only regulatory issues, but also the war in Ukraine and other commercial impacts, mainly dealing with oil and energy prices, and the changes in the Chinese policies.

Looking at the compounding phase, the prices of the materials are similar to other sources of recycled PP, but the properties of the material are fairly good and this could make their use more interesting than other sources.

For the final production plants, the compounded material need to meet the standards and the quality parameters required for their processing, while the price should be attractive enough although there are other motivations, linked to legal requirements or voluntary commitments of the different product manufacturers, to include a certain amount of recycled plastics on their products. It is expected – and it has been experienced during the project – that this kind of commitments or legal requirements may increase in the next years, leading to higher benefits for the companies that have a solid supply chain and are able to offer the same product quality, but integrating a recycled content into the parts supplied.

3.1. Conclusions of the economic analysis

Regarding the economic analysis, the following can be concluded:

- Recycling PP from bumpers obtained from end-of-life vehicles is economically viable, although it highly depends on the market prices and there can be situations where there is no benefit or even a loss.
- The transportation costs play an important role in this kind of “light” materials and environmental issues like the greenhouse emissions should be considered.
- The new regulations and the companies commitments could boost the demand of recycled plastic from post-consumer waste, leading to higher prices.

4. Techno-economic analysis

The main parameters that affect the technical and the economical viability of implementing the LIFE CIRC-ELV project have been explained. If they are analysed together, the following conclusions can be obtained:

- Only ATFs treating a high number of ELVs can implement the process in a technical, economic and environmental way. An ATF treating less than 200 ELVs a year (around 30% of the ATFs in Europe) can produce around 2 tons of this PP, obtaining 200 € at the end of the year and still having to bear the costs of transporting and storing the bumpers, which surely not compensate for the work done and the increase in greenhouse gas emissions.
- Big ATFs should optimize the process by looking at the different technical solutions available, specially considering the conditions set by the recycling company they can work with. It is highly recommended to have some machinery for reducing the size, allowing a more efficient transportation of the PP bumpers.
- The final product requirements may determine the quantities and types of additives to be used in the compounding phase, as the percentage of recycled PP that can be used. This may lead to higher costs, but also to higher value materials. There is a balance between the percentage of recycled PP and the number of additives to be used to reach a product that complies the requirements of the final product with the best price.
- Many regulatory developments (including the future regulation on ELVs) as well as initiatives, like the Circular Plastic Alliance (CPA), together with some companies voluntary commitments are leading to higher demand of recycled plastics obtained from post-consumer waste and this is improving not only the price, but is also changing the difficulties and obstacles that before and still had the use of recycled plastics in new products .
- The LIFE CIRC-ELV project has proven that it is technically and economically viable to recycle PP obtained from bumpers extracted from ELVs, although is not a turnkey solution and depends on many different aspects that need to be evaluated when implementing in a specific area.