

The UN Secretary-General's Advisory Board on Zero Waste

Advanced Chemical Recycling in Colombia: A solution for the Circularity of Difficult-to-Process Plastics



Source: Esentia

Case Study

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Executive Summary

Esenttia is the first company in Latin America to develop an advanced chemical recycling technology and produce the first 100% circular plastic (Polypropylene) by recovering difficult-to-recycle plastics. Polypropylene plastic is produced through pyrolysis, allowing the recovery of plastic waste that normally ends up in landfills or is discarded into the environment, negatively affecting the environment and human health.

Globally, it is estimated that 400,000 tons per year of plastic waste can be used by advanced chemical recycling technology, such as the one proposed by Esenttia, promoting recycling and waste valorisation, giving plastic infinite lives.

This proposed 'circular plastic' technology is the first complete solution for packaging such as food, cosmetics, and health since it produces virgin quality plastic that meets safety and global processability requirements for plastic materials.

By championing a circular economy approach, this project aims to address plastic waste and promote sustainable development and environmental stewardship. In its initial phase, Esenttia validated the business model by producing 300 tons of pyrolysis oil from difficult-to-recycle plastics, resulting in the creation of over 60 jobs within a Micro and Small Enterprise and positively influencing the recycling community.

Now advancing into the scale-up phase, the goal is to process over 8,000 tons of plastic waste by 2025, significantly impacting a recycling population of more than 10,000 individuals. Chemical recycling breaks the plastic waste down to its constituent molecular parts.

When plastic is broken down like that, it directly affects the chemistry of its polymers, making it possible to reconstitute them back to their original raw materials – and ready to be reconverted into new polymers or a petrochemical feedstock. In this case, the pyrolysis oil is used like a petrochemical feedstock to produce propylene and then produce polypropylene, this circular polymer performs like the originally obtained polymer from fossil feedstock.

In the medium term, more than 30,000 tons of plastic waste and more than 80,000 tons of other solid waste would be prevented from reaching landfills, oceans, and rivers, and in the long term, 15 to 20 years, this process would allow more than 300,000 tons of plastic waste and 1 million tons of usable waste to be diverted from disposal sites and the environment in Colombia.

Introduction

According to local sources, Colombia generates 12 million tons of waste annually, of which only 17% is recycled¹. Approximately 800.000² tons of plastic waste go to landfills annually, offering the opportunity to generate a new business model supporting the reuse and recycling principles of the waste hierarchy.

Esenttia proposes an advanced chemical recycling process for polyolefins, as a complementary solution for the difficult-to-process plastic waste that today is ending in landfills, allowing it to shift from a linear economy into a circular economy, generating high-value products, in this case, Circular Polypropylene.

To validate the business model, Esenttia developed the pilot stage through the articulation of alliances throughout the entire value chain, starting with the supplying of the raw materials to the brand owner.

The alliances were made from the assurance of the raw material (flexible material) from the recyclers and these materials were processed in the pyrolysis plant of our ally Pyrcom, then the pyrolysis oil was processed in the Ecopetrol refinery in Barrancabermeja. The molecule of interest, the propylene obtained, was taken to the Esenttia plant and converted into circular polypropylene, which will be sold to our client Taghleef to be finally brought to the market in the packaging of the brand owner Pepsi Co.

This initial scope was for Colombia, but the company is now working to expand the business to other countries. In conclusion, we integrate an ally in each part of the value chain to ensure the success of the business model.

General Description

► **Where** - Colombia

► **Specific location**

Mosquera, Colombia – It is a business model that impacts the entire Colombian market.

► **Local context**

According to local sources, Colombia generates 12 million tons of waste annually, of which only 17% is recycled¹. Regarding plastics, approximately 800.000² tons of waste go to landfills annually

► **When**

Start date (2022) ongoing or expected duration: roadmap developed for the next 15 to 20 years.

► **What is the main zero waste Issue**

In the long-term, 15 to 20 years, this process allows to process more than 300.000 tons of plastic waste and 1 million tons of usable waste.

► **Which is the main strategy applied and what tools were used**

Work in alliance throughout the entire value chain to develop and validate the business model that allows to scale up and have a bigger impact.

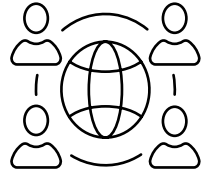
► **Partner(s)**

Esenttia, Ecopetrol, Pyrcom, Taghleef, and PepsiCo.



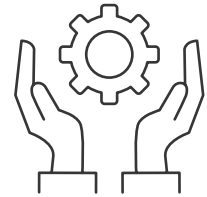
Source: Esenttia

Resources Needed



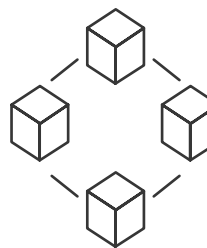
- A dedicated project team from Esenttia, Ecopetrol and Pyrcom.
- Investment in science, technology and innovation activities in 2023 for more than USD 3 million, with a future investment of more than USD 25 million.

Main Challenges



- Integration of the proposed technology value chain allowing the viability of the business model.
- Lack or limited public policy that accompanies and encourages circular economy models.
- In Latin America, the lack of incentives for new technologies or circular business models adds complexity to achieving the financial target in the business model.

Follow-up Measures



- Plastic waste processed: Tons of plastic waste processed/year
- Pyrolysis oil produced: Tons of pyrolysis oil produced/year, for 2024: 400 tons
- Circular resin produced: Tons of circular polypropylene produced/year
- Sales: USD circular polypropylene sales/year

Zero Waste

Zero waste practices, innovation and technology applicability

The main innovation of our project was the validation of the business model through the integration of all value chain stakeholders. Leveraging available technologies, particularly in pyrolysis processes for handling difficult-to-recycle plastics.

This validation marks a significant milestone as we become the first company in Latin America to successfully produce these types of polymers. Furthermore, it enables us to transition into the next phase of scaling our operations.

Governance model

1. Alignment of stakeholder Interests
2. Adaptability to change
3. Risk management
4. Regulatory compliance
5. Resource allocation
6. Continuous learning and improvement



Source: Shutterstock

Detailed Description

Process and Solutions

We proposed the advanced chemical recycling project, as a complement to our mechanical recycling project, where we realized that no solution for plastic waste is hard to recycle, mainly flexible ones, which are used in a significant percentage of food packaging applications.

For the development of stage 1, we initially worked together with a team from Esenttia and Ecopetrol to achieve the development of a local pyrolysis oil supplier, Pyrcom, owner of a pyrolysis plant, designed to recycle used tyres and produce diesel. We work to convert its technology and process post-consumer plastics, mainly flexible ones, intending to produce 300 tons of pyrolysis oil (approximately 600 tons of plastic waste), to be injected and processed at the Barrancabermeja refinery in the catalytic cracking unit, obtaining refinery-grade propylene, which was taken to Esenttia to produce a grade of Circular Polypropylene.

This Circular plastic is sold to our client Taghleef Industries at an additional premium price, who transforms it into bioriented film (BOPP), to finally be used in the manufacturing of food packaging for one of the main worldwide brands owners, PepsiCo. In this stage, the construction and validation of the business model for advanced chemical recycling in Colombia was achieved and allowed the generation of a new solution for the treatment of plastic waste (Polypropylene and Polyethylene).

In November 2023, we achieved the production of the first circular polypropylene in Latin America at Esenttia.

For the success of this stage, the articulation of each alliance throughout the value chain, teamwork and taking advantage of synergies was fundamental. It is also important to mention the development of the supply chain of raw materials from recyclers and the approach to different government entities, such as Invima to achieve regulatory approval.

Stage 2, which we began in April 2024, aims to scale the production of pyrolysis oil to achieve 4,000 Tons/year by 2025, to offer the market a regular quantity of circular polymer. At this stage we expect the participation of other brand owners, with which we are already in testing and negotiation processes, thus achieving the diversification of our portfolio of circular polymers, produced from post-consumer plastics.

In the medium term, the scaling stage will be added to stage 3 with the installation of our pyrolysis plant and the development of plants from other allies to produce, in 2027, 20,000 tons/year of pyrolysis oil in a decentralized model, in different locations throughout the country, to maximize the use and closed loop for the post-consumer plastics targeted for this project.

Results and Impacts

Our project aims to address plastic waste and promote sustainable development and environmental stewardship. In its initial phase, we successfully validated the business model by producing 300 tons of pyrolysis oil from difficult-to-recycle plastics, resulting in the creation of over 60 jobs within a small to medium enterprise and positively influencing the recycling community.

Now advancing into the scale-up phase, our goal is to process over 8,000 tons of plastic waste, significantly impacting a recycling population of more than 10,000 individuals.

In the mid-term more than 30,000 tons of plastic

waste and more than 80,000 tons of other solid waste would be prevented from reaching landfills, oceans, and rivers, and in the long term, 15 to 20 years, this would allow to processing of more than 300.000 tons of plastic waste and 1 million tons of usable waste.

Also, it is important to mention that this kind of project allows the replacement of fossil streams with sustainable streams reducing CO2 emissions throughout the life cycle and generating high-value-added products from waste (According to initial internal studies, 40% lower Lifecycle Assessment compared with fossil-based polypropylene).

Inclusion considerations

Entire recycling population should be approached and included.

Future steps, upscaling and sustainability

Stage 1: Pilot: productive activities completed, in regulatory approvals.

Stage 2: Scale-up: Process 8.000 tons per year of difficult-to-recycle plastics

Stage 3: Esenttia Pyrolysis Industrial Plant: Process 40.000 tons per year of difficult-to-recycle plastics.

Stage 4: Development of new alternatives in Cartagena Refinery

Stage 5: Different streams to replace fossil streams in the refineries.

This project has a very high scope and scalability

at a national and international level. The objective is to be able to create the necessary infrastructure in several cities in Colombia and develop the collection chain for plastics that are difficult to recycle, managing to intervene up to 50% of all waste generated in the country (more than 12 million tons).

This project provides a solution for the 100% use of recycled plastic in multiple industries (food, cosmetics, health) that currently have no possibility of increasing their recycling rates.

Lessons Learned and Recommendations

- One of the most relevant lessons learned is the importance of validating the new business model on a small scale, which allows us to scale up with a better understanding of the challenges: in our case, this first stage (Pilot) brought knowledge of the following topics:
- In a circular economy, successful businesses are built through alliances, teamwork, and collaboration. Unlike traditional linear economic models, circular economy aims to minimize waste and maximize the use of resources through closed-loop systems.
- The raw material is crucial for a successful circular economy business model. In this case, it is not only the quantity but the quality of the raw material (post-consumer plastic waste), because it impacts the chemical recycling process yield and all the subsequent production processes along the value chain.
- Policies, regulations, and frameworks that prioritize the recycling of plastic waste over sending it to landfills are important for the development of a circular economy business.
- Despite the ongoing efforts to increase recycling rates and promote sustainable waste management practices, it remains a reality that a substantial amount of waste, approximately 800,000 tons annually, continues to be disposed of in landfills. This persistent volume of waste shows the challenges in our current waste management systems. This shows us that the country needs complementary solutions, such as the Investment of local municipal solid waste sorting facilities, to guarantee supply and feedstock for circular economy businesses in the necessary quantities to scale up. It is important to mention that these facilities will not compete with the recycling population, and on the contrary, they can be a possibility of inclusion and better working conditions.
- The sorting of the municipal solid waste allows different synergies with the chemical recycling business model, such as the production of biogas from the organic fraction, the reincorporation of glass, metals, and other materials in the production process, preventing them from ending up in landfills, thus, reducing environmental impacts and promoting circular economy models and value generation through the maximum use of all residues.
- Mobilize resources and special financial conditions for circular economy projects to research and development activities, innovation, scale-up, infrastructure and market development.

Conclusion

- Difficult to process plastic waste has an alternative in Colombia to produce high value-added products with a potential volume of 300.000 tons of plastic waste by 2040.
- Circular Economy business models are possible in the region with the collaboration of all the important actors of the value chain.
- The pilot stage allowed us to accelerate the advanced chemical recycling business model by four years.
- It is important to create policies and regulations that accompany the development of circular economy business models.
- New consumer behavior trends, such as greater environmental and social awareness in consumption have motivated large brands (Nestlé, Unilever, PepsiCo, among others) to declare big goals in this decade in their sustainability objectives, where they promote the inclusion of recycled materials in their packaging as a partial replacement of virgin resins.



Source: Esentia

References

[Link to Portfolio](#)

- Data based on internal calculations and estimates.

Further Information and Media

- [Noticias en El Espectador](#)
- [La Nota Económica](#)
- [News Article Columbia Pioneering Plastic Recycling](#)
- [Enlace Televisión](#)
- [YouTube Video: Primera molécula de propileno verde](#)
- [YouTube video corporativo](#)
- [Plastics Technology Esenttia](#)
- [Anuncio en Instagram](#)
- [Ecopetrol in Colombia](#)

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Source: Esenttia