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LIFE PlasPLUS

Recycling of high-quality secondary thermoplastics and recovery of critical raw materials (antimony) from mixed plastic waste in the automotive and the electrical and electronic equipment sector

Pierre Fiasse, Comet Traitements

21-05-2024

This project has received funding from the European Union's LIFE Programme for Environment and Resource Efficiency under grant agreement No. LIFE18 ENV/BE/000368.

COMET GROUP / COMET TRAITEMENTS

COMET GROUP :

- 500 staff, 500 M€ Turnover
- Comet Sambre : 2 shredding sites, Charleroi (3.000 CV) and Mons (7.000 CV)
- 1.200.000 to/y of Wastes – 800.000 to/y metallic

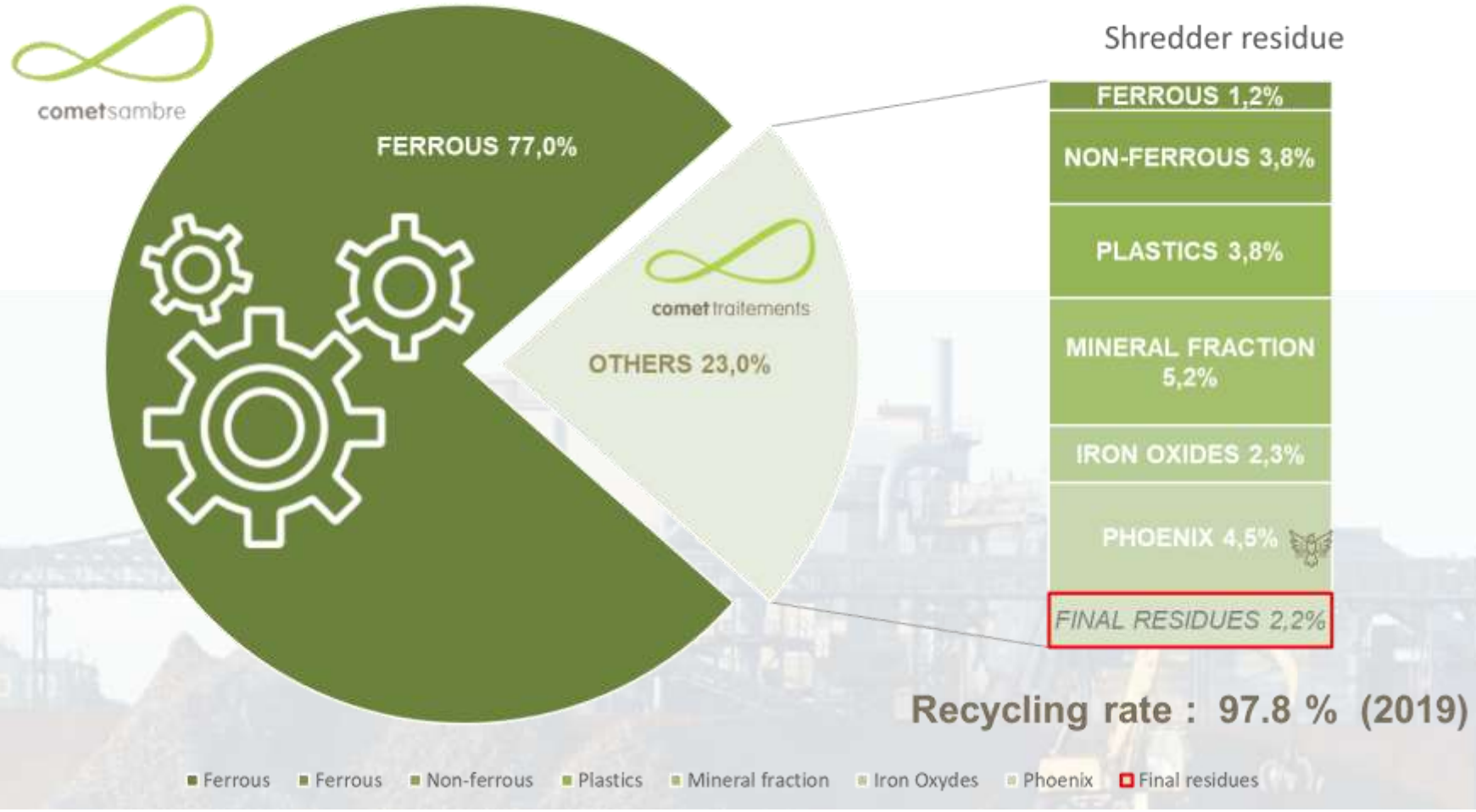
COMET TRAITEMENTS : **Shredder Residue processing and recovery**

- 8 production units : Post Shredder Technology
- Treatment capacity : 350 000 T/y ,
- Staff : 170
- R&D team: 15 + 11 external researchers work on Comet projects

FEEDSTOCK

Comet Traitements

Shredder Residues Recovery



SHREDDER RESIDUES VALORISATION
URBAN MINING

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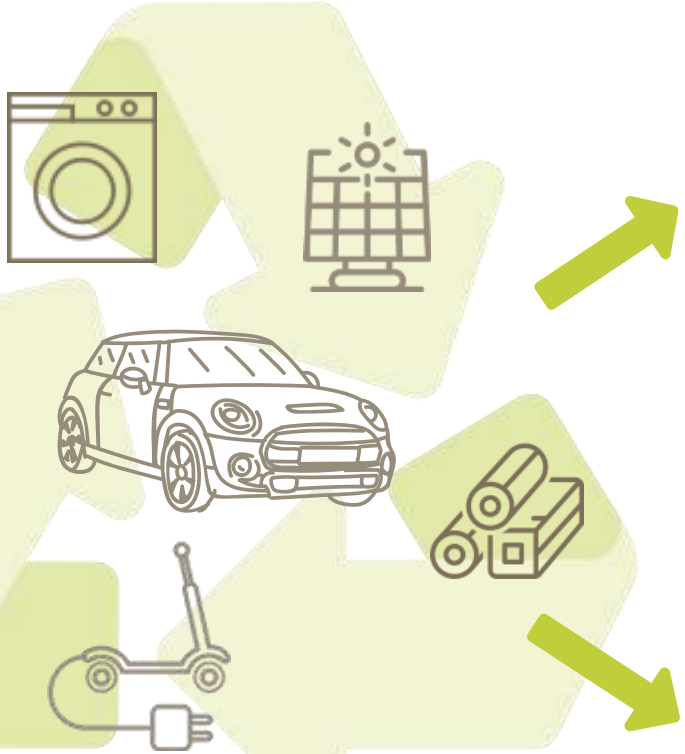
Glass

→ Technical sand



Foam, wood…

Catalytic cracking
→ Hydrocarbon

Plastics Upcycling

97,8%

Non-ferrous metals

Robotized sorting

Hydrometallurgy

Cu, Al, Zn, CRM : Co, REE, …

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LIFE PlasPLUS : CONTEXT

51

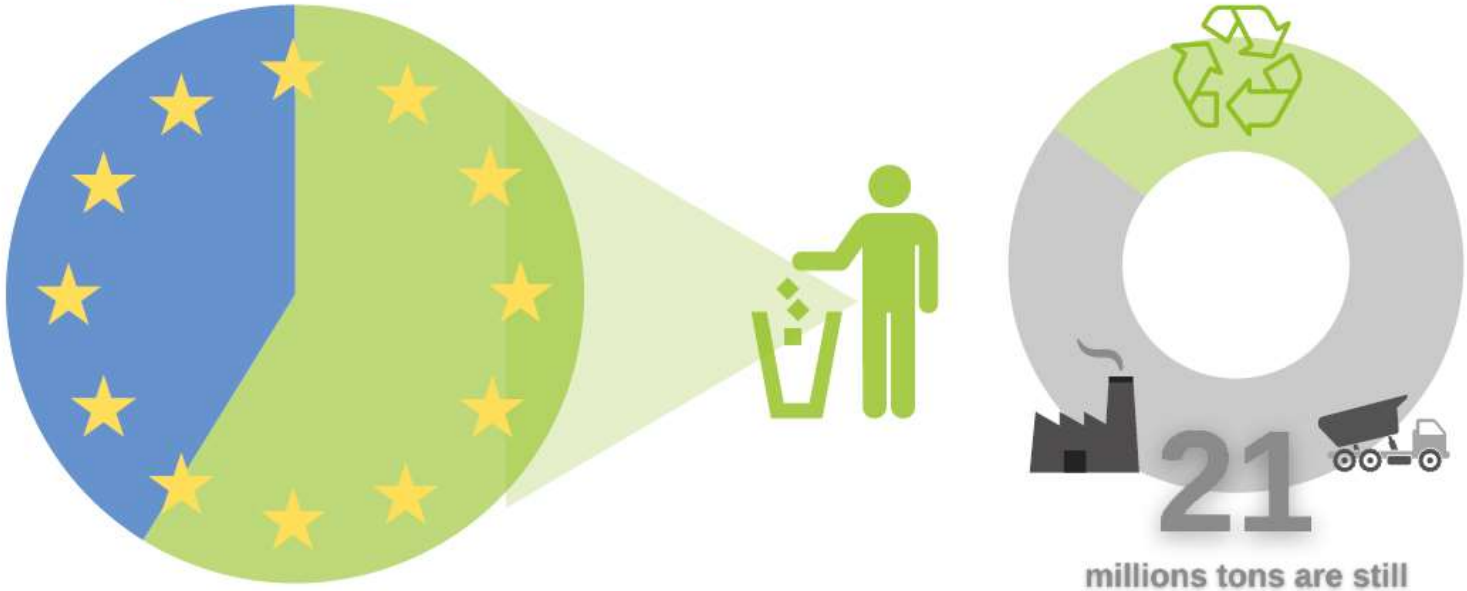
millions tons plastic used each year in Europe

30

millions tons post consumer waste plastics generated

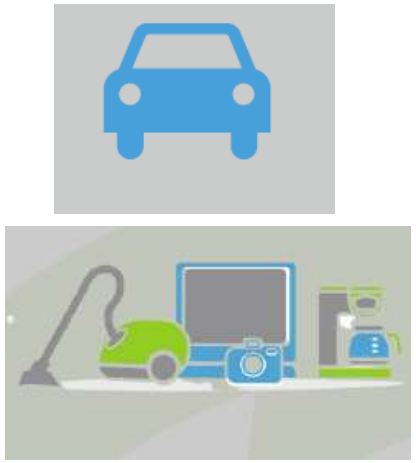
9

millions tons of waste plastics is collected for recycling.



21

millions tons are still landfilled or incinirated



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LIFE PlasPLUS : objectives

Close the loop :

- High Purity Recycled **thermoplastics** from complicated ternary plastics mixtures : ABS/PS/FPP
- Recycling **Antimony from** Brominated Flame Retardant Plastics

… two materials in high demand e.g. emerging electric mobility
→ ***lower energy consumption*** and ***increased fire safety***

→ contribute to EU ***circularity*** & ***Green Deal***

Large scale demonstration & Integration of the global value chain

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LIFE PlasPLUS : objectives

Thermoplastics heterogeneous plastic mixes

Residual Fraction - Drainaplus

Landfilling / Incineration

Downcycling

Separated & Purified Thermoplastics

PP/PE, FPP, ABS, PS

Upcycling

Rubber, Flame retardant plastics, technical plastics, wood, …

Sb

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LIFE PlasPLUS

Project Overview

Project Location : Obourg, Belgium

Project Budget :
3,170,420 Euro
1,430,450 Euro EC funding

Duration : 01/07/2019 - 30/06/2023

Coordinating Beneficiary : comet traitements

Associated Beneficiaries : LIÈGE université, STELLANTIS, CRF, Campine, SERI PLAST POLYPROPYLENE COMPOUNDS

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LIFE PlasPLUS : Partners and Material Value Chain

Plastics Recycling
Automotive Value Chain

F R Plastics Recycling
Antimony Value Chain

COMET TRAITEMENTS	SERIPLAST	STELLANTIS (CRF)	UNIVERSITY OF LIEGE	CAMPINE
Waste sorting and valorization	Plastic compounding	Car manufacturing	Research and development	Production of antimony

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Detailled objectives

1. Upcycling 45% of initial Comet's plastic waste: demonstrate industrial & economic feasibilty
2. Substitute > 40% thermoplastics with secondary ones in automotive & EEE markets
3. Validate the quality of the produced compounds in vehicle parts & FR masterbaches
4. Separate Flame retardant from the rest of the mix thanks to sensor based sorting
5. Showcase a « closed loop » production of plastics with antimony for flame retardancy

- LCA
- Business plan for each process
- Develop replication & transfer plans

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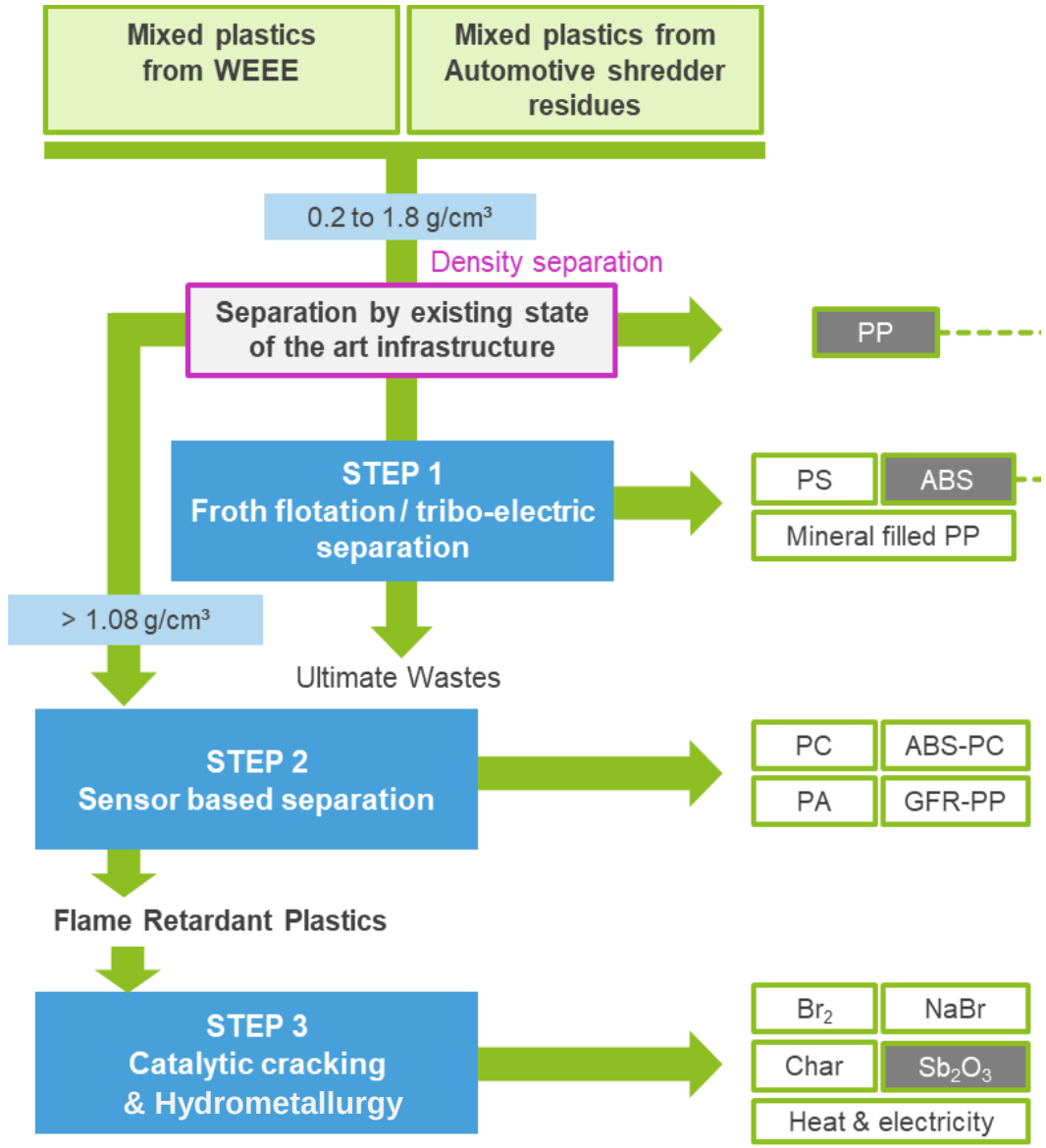
Flowsheet



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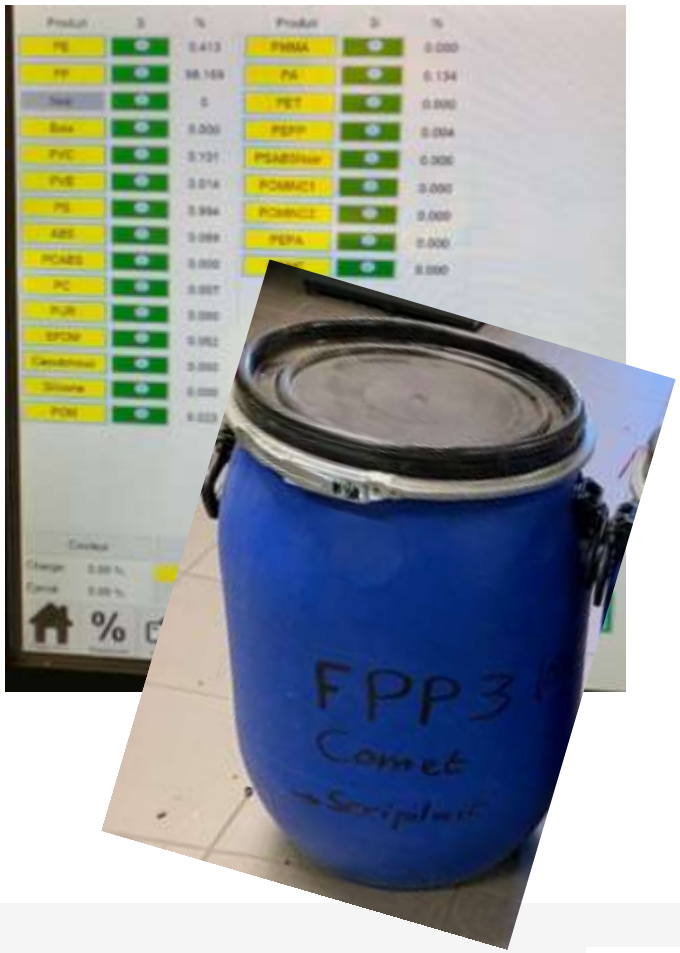
Production of high purity thermoplastics : ABS, PS & FPP

Ternary Plastic Mixture Demonstration Unit : on production to demonstrate on large quantities of ABS, PS and FPP



Treatment capacity : 1 to/h
Target : production of large scale samples

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Production of high purity thermoplastics : ABS, PS & FPP

Qualities

Recycled Thermoplastics	Quality acceptable for compounding		
	% F PP	% ABS	% PS
F PP Comet	> 98 %	< 1-2 %	< 1-2 %
ABS Comet	< 0,5 %	> 98 %	< 1,5 %
PS Comet	< 2,5%	< 2,5%	> 95%

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Production of high purity thermoplastics : ABS, PS & FPP

RoHS compliant

Heavy metals	Limit "RoHS 3" (ppm)	FPP ppm	ABS ppm	PS ppm
Cd	100	5,52	23,9	17,4 to 28,8
Pb	1000	27,2	7,93	32,5 to 62,8
Hg	1000	< 2	< 2	< 2
Cr (VI)	1000	< 8	< 8	< 8
Brominated Flame Retardant	**Limit "RoHS 3" (ppm)**	**ppm**	**ppm**	**ppm**
Sum of PBBs	1000	<5	< 5	<5
Sum PBDEs	1000	27,8	< 5	56,77 to 224,51
Details of PBDEs :				
Octabromodiphényl ether		*< 5*	*< 5*	*6,11*
Nonabromodiphényl ether		*< 5*	*< 5*	*8,67 to 25,4*
Décabromodiphényl ether		*27,8*	*< 5*	*48,1 to 193*

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Validation, Production & Testing

A. Designing new compounds incorporating recycled plastics from ELV

	CHARACTERISTICS		UNIT OF MEASURE	PP 60.35 Mineral (talc) filled copolymer 20 to 25% high flow rate	PP 65.40 ■ Mineral (talc) filled copolymer 25 to 30%		TEST METHOD
PHYSICAL	Volume		g/cm³	1.05 to 1.10	1.11 to 1.17		Std. 50432/09 ISO 1183 Method A
	Coefficient of linear thermal expansion		10⁻⁶/°C	50 to 70			Std. 50560
	Mold shrinkage *		%	0.7 to 1.2			UNI 4265
	Fluidity index Δ		g/10 min	15 to 25	4 to 10		Std. 50567 (cond. C) ISO 1133 (cond. M)
	Calcination residual		%	18 to 27	23 to 32		Std. 50438 ISO 3451/1
MECHANICAL	Tensile stress (min.)	Elongation	%	20	15		ISO 527 (Specimen Type 1B, speed = 50 mm/min)
		Max. load	N/mm²	23	20		
	Flexural modulus of elasticity (min.)	at -30 °C		- - -	5300		ISO 178 (speed = 2 mm/min)
		at 23 °C		2200	2.500		
		at 60 °C		1.000	1050		
		at 80 °C		850	950		
	Flexural strength (min.)	at -30 °C		- - -	70		
		at 23 °C		35	35		
		at 60 °C		18	19		
		at 80 °C		12	13		
	IZOD resilience with notch (min.)	at 23 °C	kJ/m²	3.5	4	7	ISO 180/A
		at 0 °C		3	3	3.5	
		at -30 °C		2	2	2.5	
	Falling dart impact resistance (min.) ◀	at 23 °C	J/mm	3.5	5	7	Std. 50424
		at 0 °C		1.5	2	4	
		at -30 °C		- - -	- - -		
THERMAL	Distortion temperature under load (load = 1.8 MPa) (min.)		°C	60	55	60	ISO 75
	Vicat softening temperature (5 daN) (min.)			64	57	57	Std. 50560 ISO 306 VST B50
	Thermal oxidation		h	>150			Std. 50432/08 ISO 4577
	Resistance to combustion		-	In compliance with specifications indicated on drawing or relevant part Standards			Std. T-02000

Spec sheet Stellantis/ PP interior part

Stellantis semi-structural interior parts

Selection :

- 2 PP compounds
- 2 ABS/PC GF, ABS GF compounds :

⇨ Compounding target for Seriplast

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LIFE PlasPLUS

Validation, Production & Testing

A. Designing new compounds incorporating recycled plastics from ELV

2 tons of F PP Regrind - 2 tons of ABS Regrind shipped to SeriPLAST

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Validation, Production & Testing

A. Designing new compounds incorporating recycled plastics from ELV

FPP Comet Regrind

Seriplast compound
100% recycled FPP

Compounding optimisation & extrusion by Seriplast

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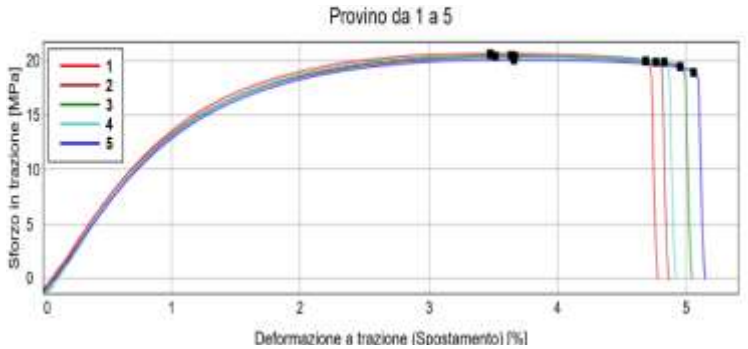
Validation, Production & Testing

A. Designing new compounds incorporating recycled plastics from ELV

			55246	FPP COMPOUND
Properties	ISO	UM	PP 60.35	FPP 60.35 R
MFI	ISO1133	g/10min	15-25	20
Ash Content	ISO3451	%	18-27	26.4
Density	ISO1183	g/cm^3	1.05-1.10	1.09
IZOD	ISO 180	kJ/m^2	3.5	4.69
Flexural Modulus	ISO 178	MPa	2200	2384,5
Flexural Strenght	ISO 178	Mpa	35	35.5
Tensile Strength (elongation at break)	ISO 527	%	20	5
Tensile Strength (max load)	ISO 527	MPa	23	23
VICAT	ISO 306	°C	64	68.8



Characterisation

Quality validated

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Validation, Production & Testing

B. Injection of Fiat 500 part with 100% recycled FPP Comet compounds

PP65.40 (100% F PP recycled)

Injection validated

PP 60.35 (PP 50.20R) (100% F PP recycled)

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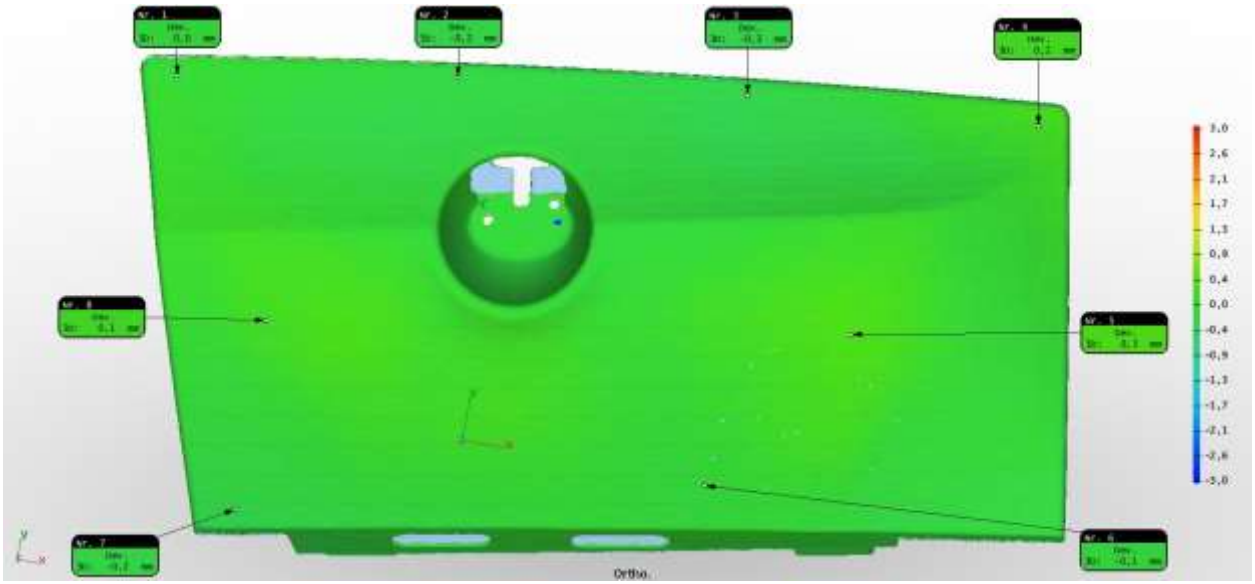
Validation, Production & Testing

B. Injection of Fiat 500 part with 100% recycled FPP Comet compounds

Validation : Deformation after Thermal Cycle



Deformations: -0,2 and 1,9 mm : inside standard limits

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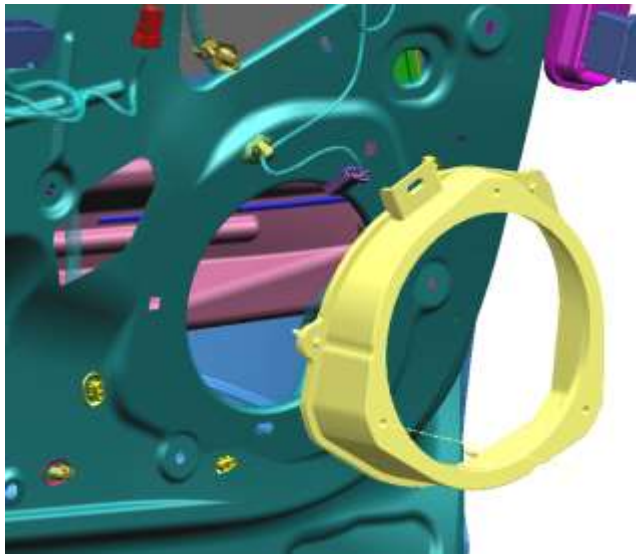
Validation, Production & Testing

C. ABS-PC-Glass Fiber Compound : same approach on speaker adaptor



Speaker adaptor > validated with 75% recycled ABS

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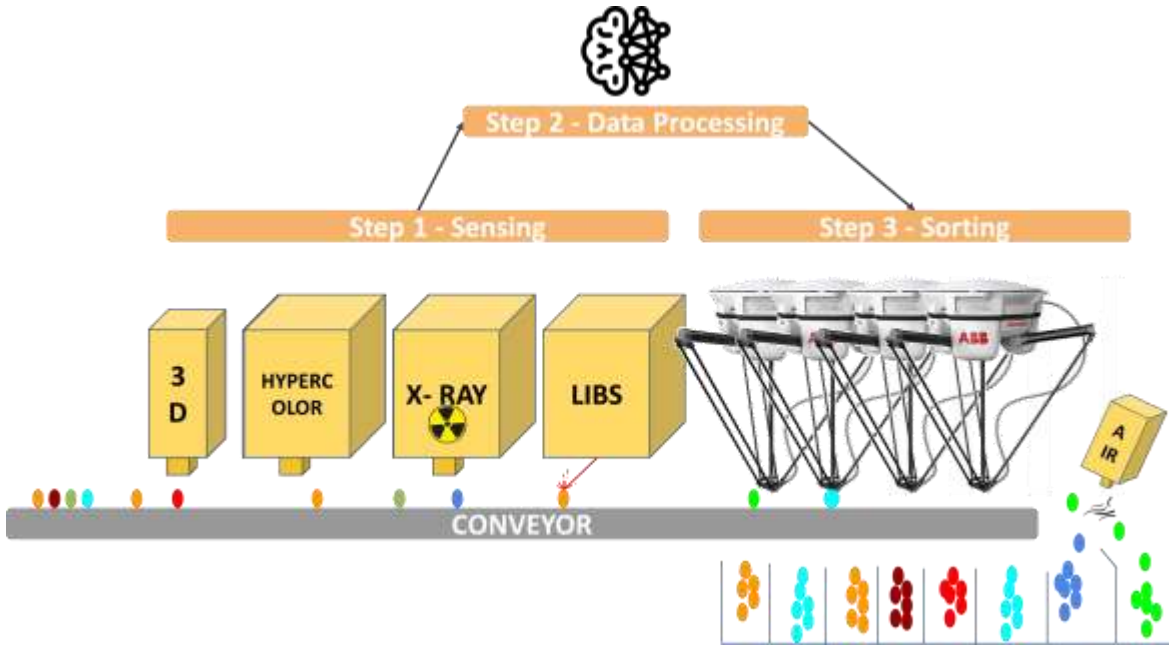
Antimony recovery

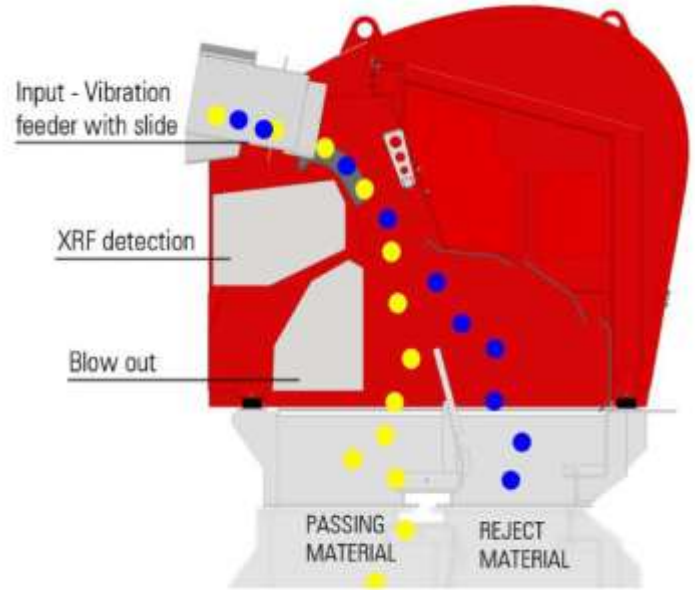
A. Extraction and purification of the Flame Retardant Plastics

2 technologies based on Br detection :

a) PICKIT Pilote (Uliege) : Multi sensor & multi-class robotic sorting with a LIBS setup adjusted to FRPP

b) XRF sorting





Successful separation : FR plastics fraction with Br separated = 10% of residual plastics

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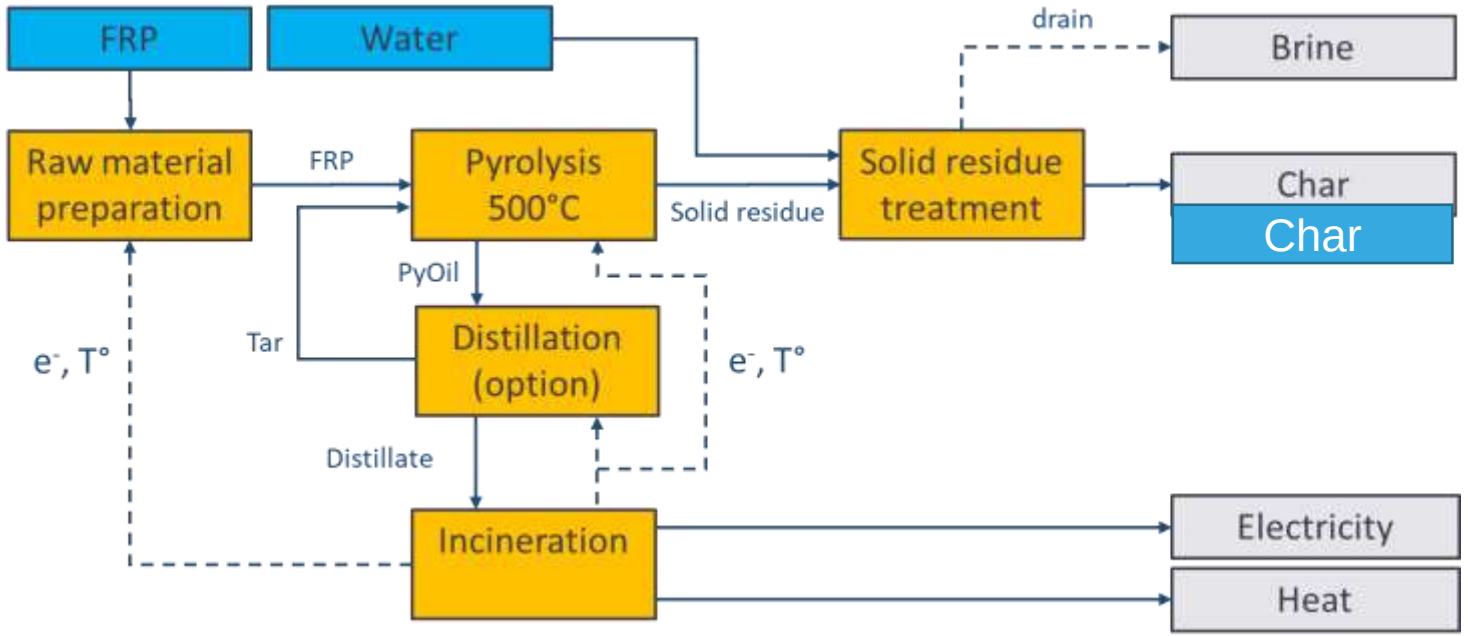
Antimony recovery

B. Pyrolysis of the Brominated Flame Retardant Plastics

PYROLYSIS Pilot Campaign



- ≥ 92% Sb from FRP goes to quenched char
- 5% to 6% Sb in the quenched char

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Antimony recovery

C. CHAR to Antimony

Sb-Char treatment

Université de Liège :

oxidative hydrometallurgical route to produce the Antimony Trioxide (ATO) for Campine.

Campine

Exploring alternative pyro route

Produce Flame Retardant Masterbatch

↳ Good mechanical, physical and fire resistance properties

Recycled ATO

FR masterbatch : rABS + rATO

masterbatch injection molded

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Impact - Industrial

Plastic purification unit in operation after 1 year project completion

- 8,687 tons of purified ABS, FPP and PS sold during project
- capacity of 50,000 tons/y waste expected (2024)
- 16,000 t/y purified thermoplastics diverted from landfilling & re-entering automotive & EEE market

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Impact - Industrial

Upcyling has been demonstrated with high impact on European circular value chains

- car interior part with
  - 100% FPP
  - 75% ABS recycled content showcased
- opens the door to circular, closed loop recycling in the automotive and EEE sector

Replication potential is high for the thermoplastic purification unit

- Payback time 4 – 7 years

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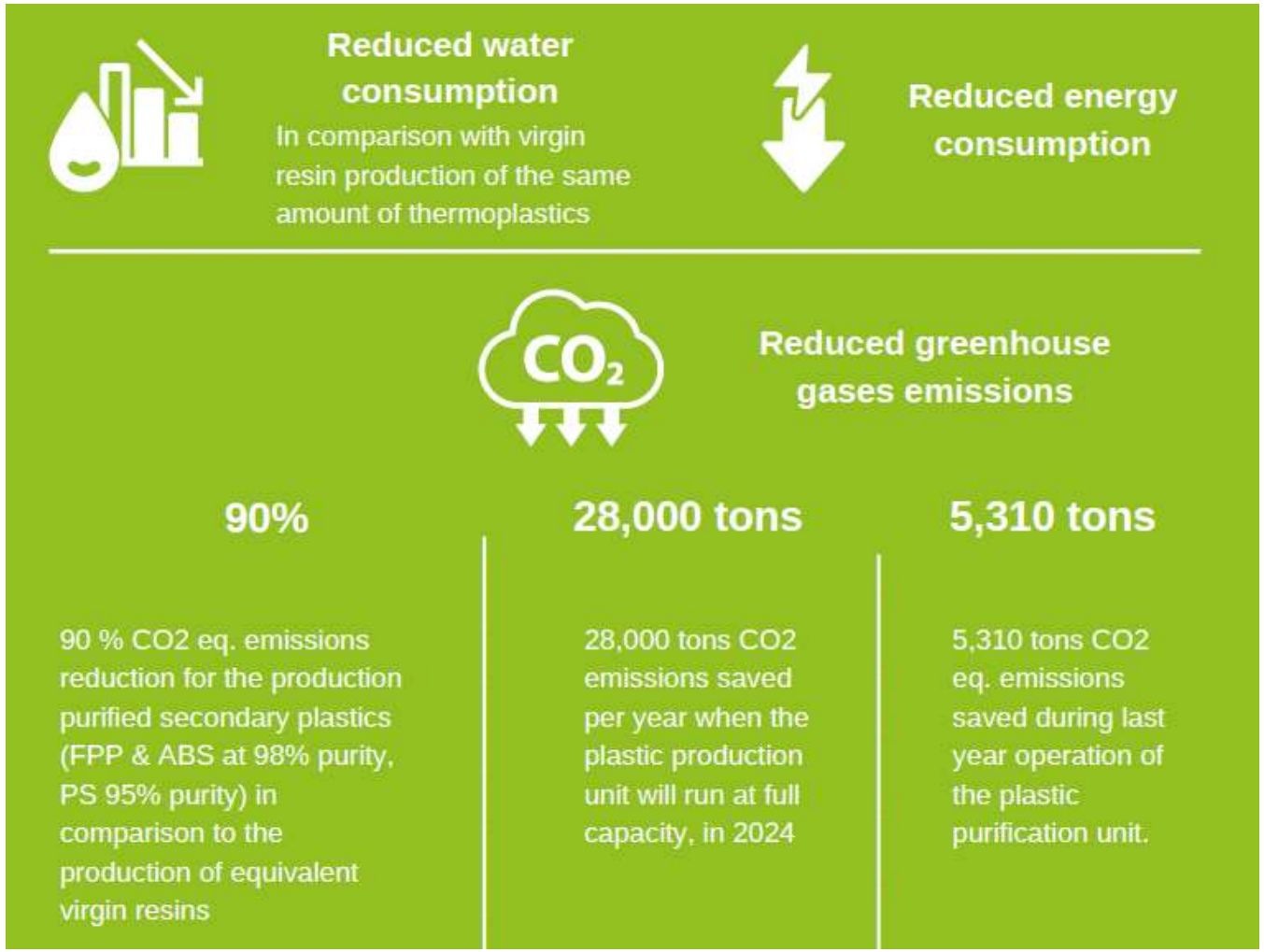
Impact – environmental



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After LIFE Plan

Activities

1. Dissemination and awareness campaigns
2. Ramp up & upscale the thermoplastic purification plant
3. Replication at other European sites
4. Participating actively in the development of the new value chain & business model with key value chain actors
5. Replicate compounds formulations on other end user applications
6. Improve recovered antimony purity and its production trough optimization of the process & develop the market.
7. Further Research & development.

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After LIFE Plan

- Contacts ongoing with Stellantis, suppliers & other automotive companies
- Policy context - 2023:
  - New End of LIVE Vehicle directive : 25% plastic recycled content
  - CRM Act
- But … virgin plastic price dropped dramatically end of 2023

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Lessons learned

Concluding remarks

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LIFE standard actions projects – opportunity ?

- Work with industrial value chain actors – access to market exploitation
- Transfert of techno from research actors
- Bottom up calls : you choose your idea
- Industrialy led / close to the market
- Small project - small consortium possible (3-5 partners, 3 years, 3 M€)

  ➔ easier to manage
- Companies / beginners are welcome - Project Officer aware !
- Support agency (Elmen) : ++

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LIFE standard actions projects – attention points

- Focus on problems of international level
- Objectives > quantitatives = written in the grant
  - Small deviations allowed
  - But be cautious in setting up objectives
- Don’t underestimate
  - Management technical & financial
  - Administrative work : reports
  - Non technological tasks : dissemination & exploitation activities

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Dissemination & exploitation activities

https://www.lifeplasplus.eu/

- Mid term Conference
- Final Conference

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Dissemination & exploitation activities

- Market analysis
- Business plans
- IPR workshop – exploitation plan
- Socio-economic assessment

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LIFE PlasPLUS

LIFE standard actions projects – attention points

- Focus on problems of international level
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  - Management technical & financial
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  - Non technological tasks : dissemination & exploitation activities

➔ Allocate sufficient time & budget

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LIFE standard actions projects – attention points

- Be aware of participation rules
  - Specific to LIFE
  - Eligible costs – time sheets – hourly rate >> seek for support (ELMEN, NCP)
  - Multiple offer for all costs : consumables, subcontracting !
- Management : financial & administrative
  - Seek expertise : in-house, partners, external support
  - Better as partner
  - Subcontracting possible but expensive
- Dissemination activities :
  - Ideally an experienced RTO partner or a consulting company as partner

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THANK YOU

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