

Considerations for Economic Success in Plastic Recycling Structure

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(revised / updated for UM Colloquium – 25 Jan 2023)

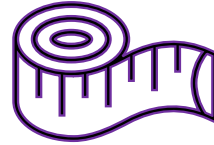




Technical consulting



Engineering



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Recyclability & Sustainability



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Institute for recyclability and product responsibility

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Institut cyclos-HTP GmbH
Institute for recyclability and
product responsibility

about 50 employees,
disciplines covering :

- Process engineers
- official experts for packaging recycling
- official experts for machinery and plants
- Electronic engineers
- Construction engineers*
- Mechanical engineers
- Chemical engineers
- Management assistant Trainees

*We work with Autodesk Inventor®

Engineering



Plastic Recycling



Clients of HTP (excerpt) in the Plastic & Plastic Recycling Industry:



The core competencies of HTP cover the entire range of plant engineering for the recycling of waste, including

- plastics and polymers,
- packaging waste,
- residual waste,
- paper,
- C & I and bulky waste.



Polyolefin Recycling, Feasibility study

Capacity: 50.000 t/a Input
35.000 t/a Output

Location: France, Refinery

Status: not implemented



Design: 3 modules

- Sorting
- Washing
- Extrusion / Regranulation

Products: rHDPE – granulate / - compound
rPP – granulate / -compound

- 1 Structures in plastic recycling
- 2 Facts and figures for sorting and reprocessing
- 3 Cost analysis of value chains
- 4 Price analysis of virgin polymers
- 5 Drawing the sums
- 6 Key figures & Summary





1. Structures in plastic recycling

Plastic recycling has been good practice since the early days of plastic industry. Post-industry waste is recycled and taken as feedstock to substitute virgin plastics. **The challenge is with post-commercial waste plastics**, which are mixtures of different polymers **and with post-consumer waste streams**, which contain any type of polymers along with other waste material.

collection	Sorting By type of polymer/material	Reprocessing		Feasibility	
		washing	extrusion	technical	economical
post-industry	-	-	+	✓✓	✓✓
post-commercial	+	o	+	✓	✓
post-consumer	++	++	+	shall be looked at in the presentation	

Legend: ✓ successful - not needed o little need + needed

1. Post consumer waste streams containing plastics

SOURCE		Post consumer waste streams containing plastics			
COLLECTION	collection	residual waste	segregated recyclables	Deposit refund scheme (DRS)	
					
SORTING	sorting	<ul style="list-style-type: none"> • single/split-line • yield 5 – 20 % plastics (all Polyolefins, PET) 	<ul style="list-style-type: none"> • single/split-line • yield 50 – 80 % plastics (all Polyolefins, PET, PS) 	<ul style="list-style-type: none"> • single-line • yield 100% plastics (PET, HDPE) 	
REPROCESSING	washing	<ul style="list-style-type: none"> • min. 3-lines (LDPE-film, HDPE/PP, PET) • yield 55 – 75 % 	<ul style="list-style-type: none"> • min. 4-lines (LDPE-film, HDPE/PP, PET, PS) • yield 65 – 85 % 	<ul style="list-style-type: none"> • min. 3-lines (PET-clear, PET-colour, HDPE) • yield 75 – 95 % 	
	extrusion	<ul style="list-style-type: none"> • min. 2-lines (Polymers, PET) • yield 94 – 98 % 	<ul style="list-style-type: none"> • min. 3-lines (Polyolefins, PET, PS) • yield 94 – 98 % 	<ul style="list-style-type: none"> • min. 3-lines (Polyolefins, PET) • yield 96 – 99 % 	

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2. Facts and figures for sorting and reprocessing

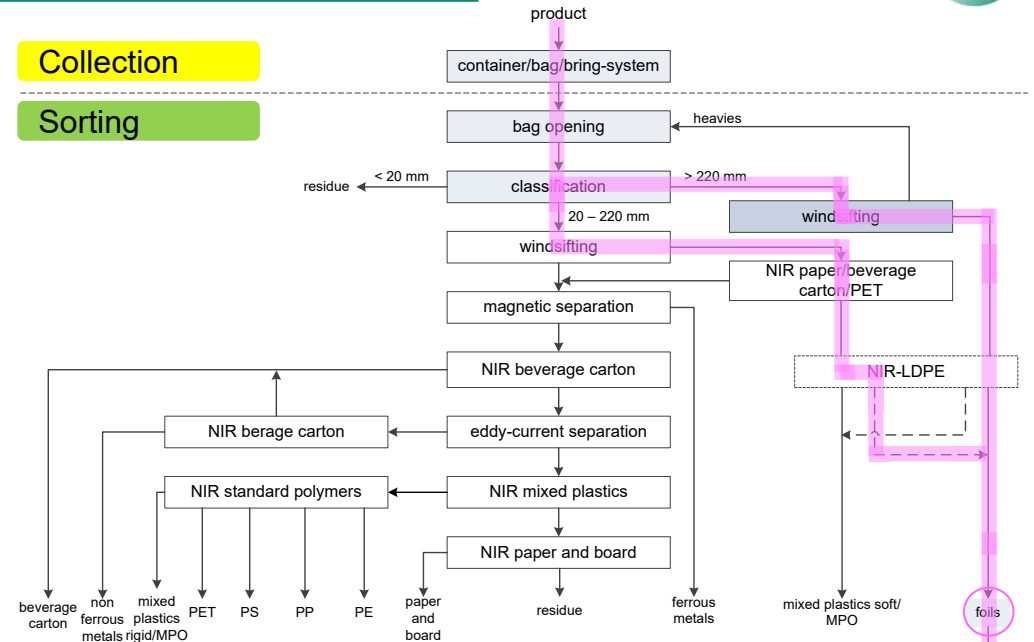
Modules in LDPE film sorting

	residual	segregated	DRS
capacity	35 t/h 240,000 t/y	12 t/h 80,000 t/y	4 t/h 20,000 t/y
yield	8 %	20 %	-

	residual	segregated	DRS
capacity	19,200 t/y	16,000 t/y	-
yield	55 %	65 %	-
Output	10,560 t/y	10,400 t/y	-

Collection

Sorting



Reprocessing

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2. Facts and figures for sorting and reprocessing

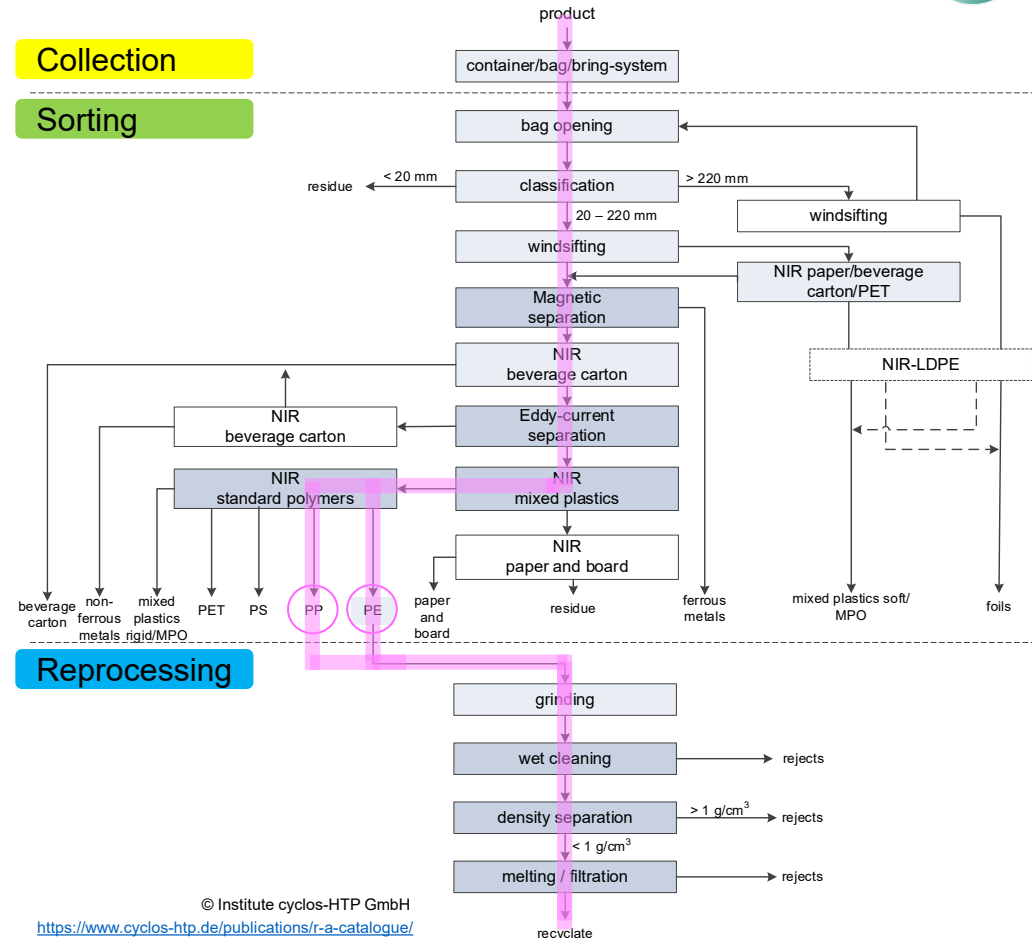
Modules in HDPE/PP sorting

	residual	segregated	DRS
capacity	35 t/h 240,000 t/y	12 t/h 80,000 t/y	4 t/h 20,000 t/y
yield	4 %	15 %	20 %

	residual	segregated	DRS
capacity	9,600 t/y	12,000 t/y	4,000 t/y
yield	70 %	80 %	90 %
Output	6,720 t/y	9,600t/y	3,600 t/y

Collection

Sorting



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2. Facts and figures for sorting and reprocessing

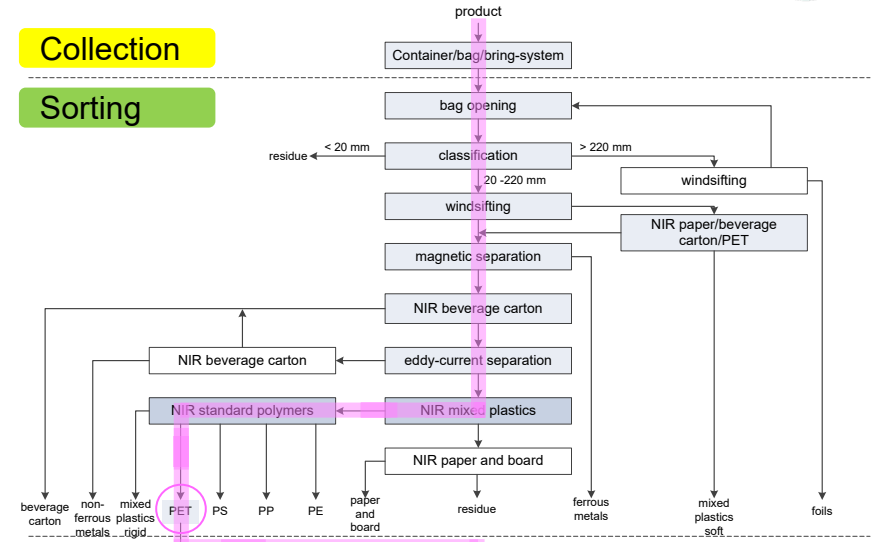
Modules in PET-bottle sorting

	residual	segregated	DRS
capacity	35 t/h 240,000 t/y	12 t/h 80,000 t/y	4 t/h 20,000 t/y
yield	4 %	30 %	70 %

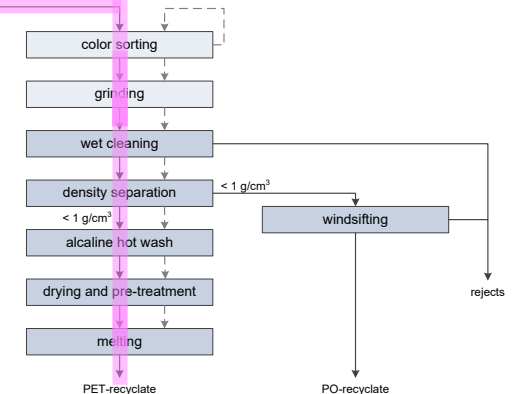
	residual	segregated	DRS
capacity	9,600 t/y	24,000 t/y	14,000 t/y
yield	70 %	80 %	90 %
Output	6,720 t/y	19,200 t/y	12,600 t/y

Collection

Sorting



processing



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3. Cost analysis of value chains

Specific cost figures

		LDPE/PP	HDPE/PP	PET
Sorting	residual	120 €/t		
	segregated	180 €/t		
	DRS	80 €/t		
washing	residual	300 €/t	280 €/t	280 €/t
	segregated	280 €/t	250 €/t	250 €/t
	DRS	- €/t	200 €/t	-250 €/t
extrusion		280 €/t	250 €/t	400 €/t

Value chain figures (processing cost)

The specific cost figures are taken to calculate the value chain figures of processing the polymers by applying the information got so far e. g.

$$\begin{aligned}
 \text{LDPE}_{\text{residual}} &= \text{cost}_{\text{sorting}} \times \text{volume} + \text{cost}_{\text{washing}} \times \text{volume} + \text{cost}_{\text{extrusion}} \times \text{volume} \\
 &= \text{production cost}
 \end{aligned}$$

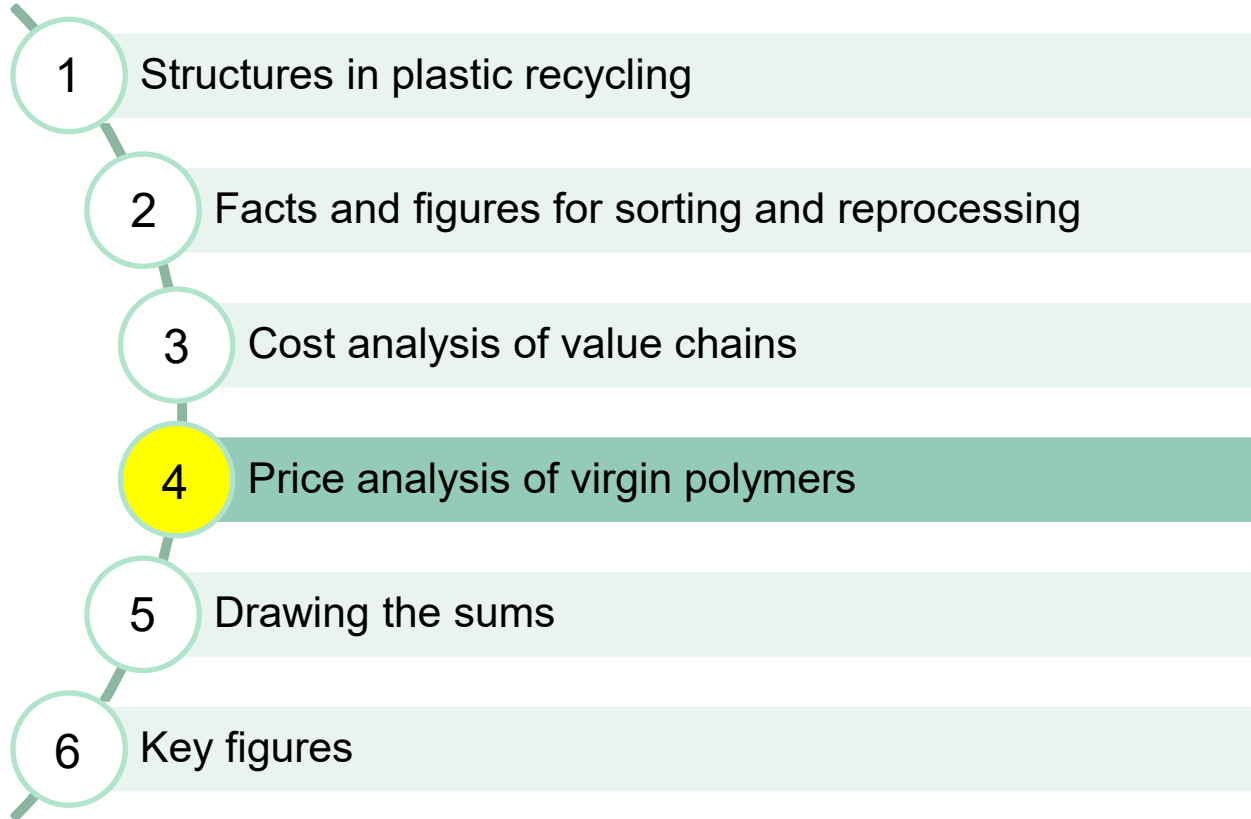
3. Cost analysis of value chains

Value chain figures (total cost)

Remark:

- Collection cost are to be allocated for source segregation and DRS schemes
- Disposal cost are to be allocated for residues of sorting and washing processes (110 €/t)

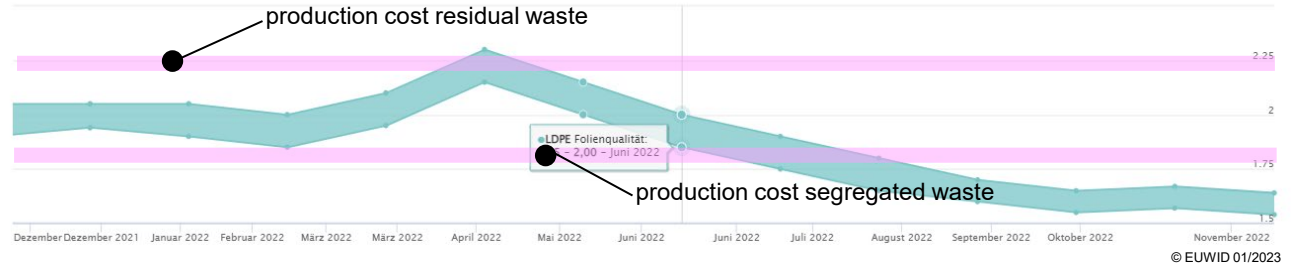
		Production cost			
		total processing	collection	disposal	per unit / per ton
LDPE	residual	23,116,800 €/y		1,045,440 €/y	2,288 €/t
	segregated	11,506,286 €/y	350 €/t	4,197,600 €/y	1,860 €/t
	DRS				
HDPE, PP	residual	10,992,000 €/y		290,400 €/y	1,721 €/t
	segregated	7,457,143 €/y	350 €/t	3,810,400 €/y	1,524 €/t
	DRS	2,055,556 €/y	900 €/t	48,400 €/y	1,471 €/t
PET	residual	12,576,000 €/y		580,800 €/y	1,871 €/t
	segregated	19,851,429 €/y	350 €/t	4,100,800 €/y	1,384 €/t
	DRS	9,784,444 €/y	600 €/t	169,400 €/y	1,377 €/t



4. Price fluctuation virgin polymers (1/2)

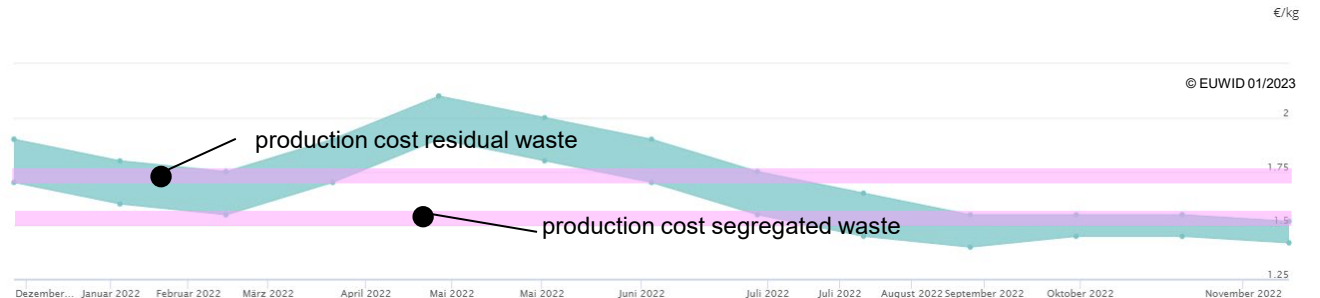
LDPE-film grade

LOW-level: 1.500 €/t
HIGH-level: 2.400 €/t
Fluctuation: +/- 38 %



HDPE-injection moulding

LOW-level: 1.400 €/t
HIGH-level: 2.100 €/t
Fluctuation: +/- 33 %



4. Price fluctuation virgin polymers (2/2)

PET-bottles

LOW-level: 1,250 €/t
HIGH-level: 1,750 €/t
Fluctuation: +/- 29 %



5. Drawing the sums



The main recycling structures are residual waste collection/sorting, source segregated collection/sorting and deposit refund schemes (DRS).



The total volumes to be processed to get the same volumes of recycled polymers are 3 to 5 times higher when processing residual waste streams against source segregation or DRS.



The production costs when sourcing recycled polymers from residual waste are the highest compared to source segregation or DRS-schemes, even taking additional collection and disposal cost into consideration.



Source segregation and DRS schemes do not deviate significantly in production cost; the main difference is the limited coverage of packaging types with DRS-schemes.



The price of virgin polymers do not cover the production cost of recycled polymers from any of the recycling structures. Additional financing like licenses or premiums on virgin prices are needed.



The prices of virgin polymers over the period of the last 12 months varied between 1,400 €/t (LOW) and 2,400 €/t (HIGH) for Polyolefins and 1,250 €/t (LOW) and 1,750 €/t (HIGH) for PET-A bottle grade.



The total cost to collect and process recycled polymers varied between, 1,550 €/t and 2,300 €/t for r-HDPE, r-PP and r-LDPE and between 1,400 €/t and 1,900 €/t for r-PET.



Profitability of plastic recycling is being jeopardized by fluctuation in virgin prices/oil prices (HIGH levels in spring 2022 mainly due to the Ukraine crisis). LOW levels cannot be weathered by small and medium sized companies of the recycling industry.



Profitability is safeguarded only with a premium for recycled polymers on virgin prices or alternative financing e.g., Extended Producer Responsibility (EPR) licenses.



Presently, r-PET is traded at a premium (20–30%) against virgin PET, that makes r-PET a profitable business.



Prospectively, Polyolefin recycling would be profitable if traded with a premium against virgin as well. To achieve this, r-Polymer prices need to be decoupled from the oil market and a recycled content should be mandatory.

Any comments or questions, please contact:



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