



RecyClass Unwrapped

Scientific testing with RecyClass – Protocols explained

Moderated by
Karlheinz Hausmann | Senior TS&D/R&D Fellow | Dow

RecyClass

Increasing recyclability through scientific testing with RecyClass

RecyClass Unwrapped Webinar
28-04-2021

Contact: fabrizio.digregorio@plasticsrecyclers.eu



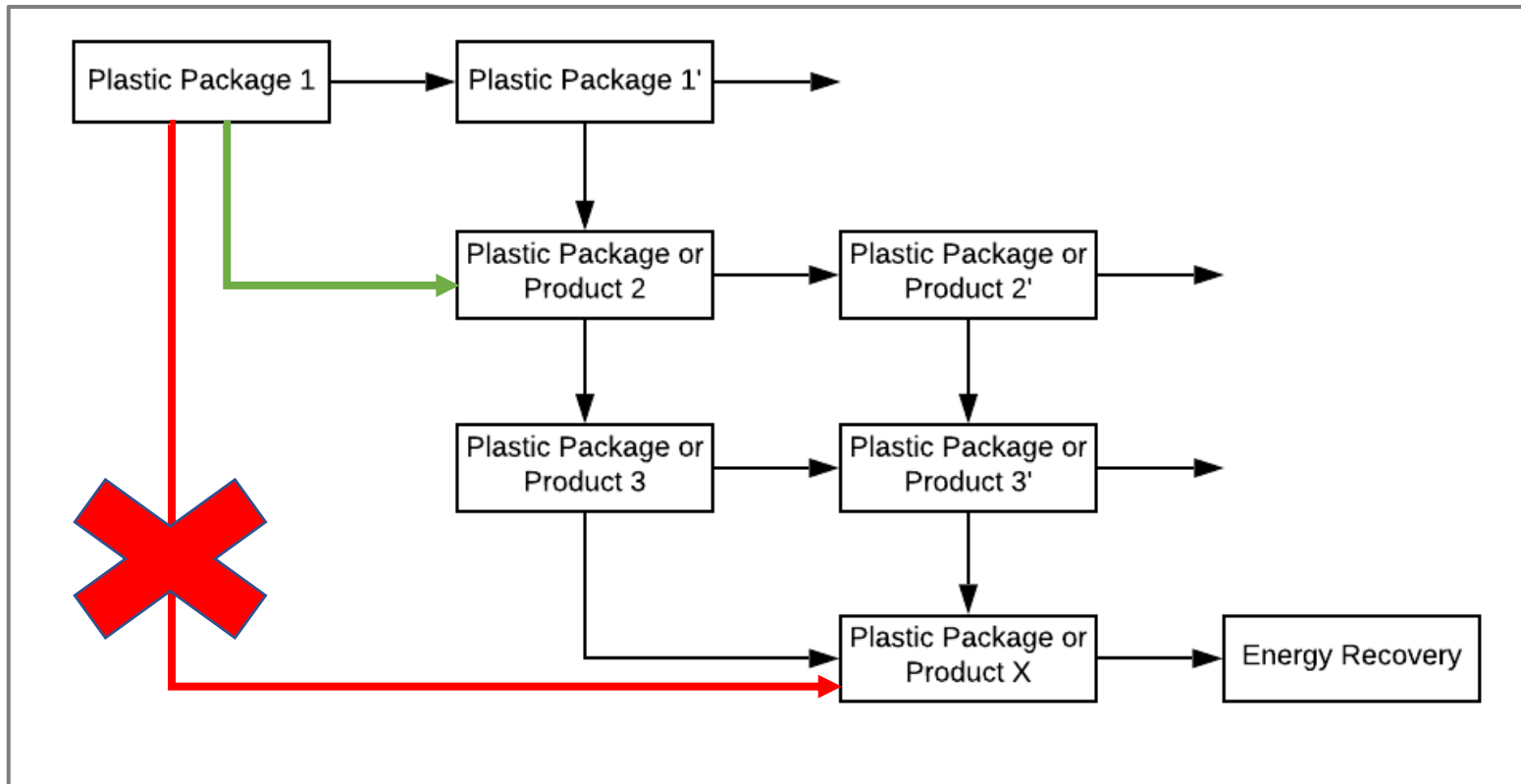
The importance of harmonised and scientific-based information

- **Harmonised Evaluation Protocols and Design Guidelines are essential**
 - ✓ Strengthens and gives credibility to the message;
 - ✓ Provides for effective communication with stakeholders;
 - ✓ Provides clear direction for design for recyclability policies within brands.



What does CIRCULARITY mean?

‘A circular economy is one that is restorative and regenerative by design and **aims to keep products, components and materials at their highest utility and value at all times**’ (MacArthur, 2015)



There are cases where functionality requirements make certain packaging hard to be designed for closed-loop recycling systems.

However, design choices leading to **the longer multiple-step cascaded recycling must be favoured.**

What we need are data!

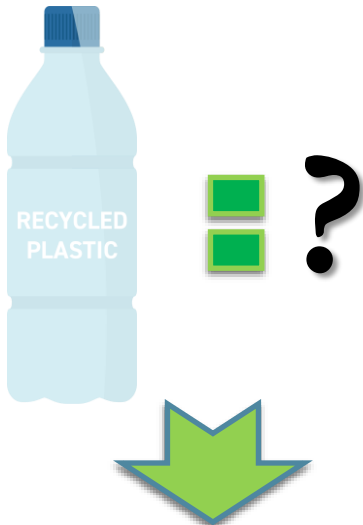
Recyclability Evaluation Protocols



Design for Recycling Guidelines



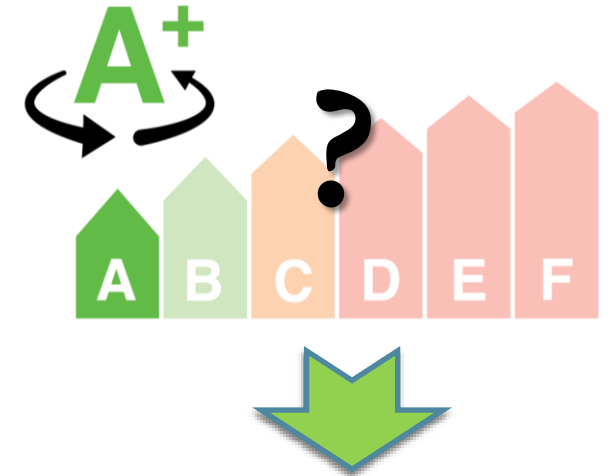
RecyClass Tool



RecyClass PE TRANSPARENT FLEXIBLE FILMS for Household and Commercial Packaging

	YES - FULL COMPATIBILITY A-B	CONDITIONAL - LIMITED COMPATIBILITY B-C	NO - LOW COMPATIBILITY D-E-F
DESCRIPTION (See Protocol)	Materials that passed the testing protocols with no negative impact on materials that have not been tested (yet), but are known to be acceptable in PE recycling.	Materials that passed the testing protocols if certain conditions are met on materials that have not been tested (yet), but pose a low risk of interfering with PE recycling.	Materials that failed the testing protocols on materials that have not been tested (yet), but pose a high risk of interfering with PE recycling.
MAIN MATERIAL	PE LD, PE LLD, PE HD	Multi-layer PE/PP	Any other polymer (e.g. PET, PVC, etc.)
MATERIAL COMPOSITION	A when PE content is > 95%; B when PE content is > 90%	C when PE content is > 70%	D when PE content is > 50%; E when PE content is > 30%; F when PE content is > 10%
COLORS	Unpigmented; transparent	Light colours; translucent colours	Dark colours; black; carbon black
SIZE	> 40 µm x 50 mm once compacted	> 40 µm or between 20 and 40 µm once compacted (starting test)	> 20 x 20 mm
PRODUCT RESIDUES (Easy to Empty index)	A if the index is < 5%; B if the index is < 10%	C if the index is < 15%	D if the index is < 20%; E < if the index is 20%; F if the index is > 20%
BARRIER	Barrier to the polymer matrix; SIOs and SIOs without additional coatings	< 5% EVOH (in polyolefin combination film); metallized layers without SIOs; Eastman High Plus 10	> 5% EVOH (in polyolefin combination film); barrier layer PVC, PVDC, PE, any other barrier layer; flame-retardant agents used as expandable chemical agents; aluminium
ADDITIONS	Additives that do not increase the density higher than 0,37 g/cm³	PP, removable aluminium fillings	Bio-/bio-photodegradable additives; Additives that do increase the density higher than 0,37 g/cm³ (CaCO₃, talc, glass fibers, etc.)
CLOSURE SYSTEM	PE LD, PE LLD, PE HD	PP	Metal, aluminium, PVC, PET, PETG, PS, PLA, non-PO or foams with density < 1 g/cm³
LINEARS, SEALS AND VALVES	PE LD, PE LLD, PE HD	PP, removable aluminium fillings	Metal, aluminium, PVC, PET, PETG, PS, PLA, foiled paper, non-PO or foams with density < 1 g/cm³
LABELS	PE	PP, paper labels without fillers	Metal/foiled labels, any other: paper labels with fillers
ADHESIVES FOR LABELS	Water soluble or water-releasable at less than 60°C	Non-toxic (according to EUPLA guidelines)	Adhesives non-soluble in water or non-releasable in water at less than 60°C
INKS	No inks	Printing covering > 50%*	Inks that bleed; Toxic or hazardous inks
DIRECT PRINTING	Laser marked print; Printed production or expiry date	PP	Printing covering > 50%*
OTHER ATTACHMENTS	PE LD, PE LLD, PE HD		Metal, aluminium, PVC, PET, PETG, PS, PLA, paper, foams with density < 1 g/cm³
RECYCLED CONTENT			

* Class ranking resulting from the RecyClass assessment. B class is reported twice because of the 50-60% amount of PE in the packaging or because of slight incompatibilities in the design.
** temporary solution



- **Test** on recycled product with and without innovation.
- Comparison of properties
- **Technology/Product Approval**

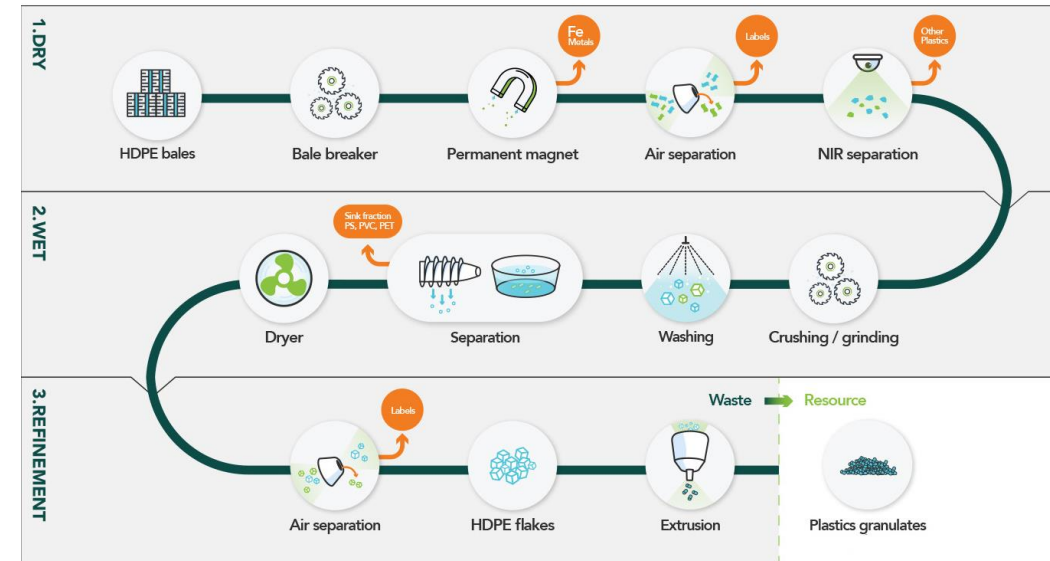
- The DfR Guidelines are transposed to the tool.
- The overall recyclability of the finished package can be assessed.

- Recyclability Self-Assessment
- Recyclability Expert-checked
- **Recyclability Certification**

RecyClass

RecyClass Testing Protocols

- Recyclability Protocol for PE films
- Recyclability Protocol for HDPE containers
- Recyclability Protocol for PP containers
- Recyclability Protocol for PP films
- Recyclability Protocol for PET bottles (EPBP)
- Recyclability Protocol for PET trays (Petcore Europe)
- Sorting Protocol for plastic packaging (*to be released in June*)
- Washing Procedure for film labels and adhesives (*to be released in May*)
- Washing Procedure for paper labels and adhesives (*to be released in May*)

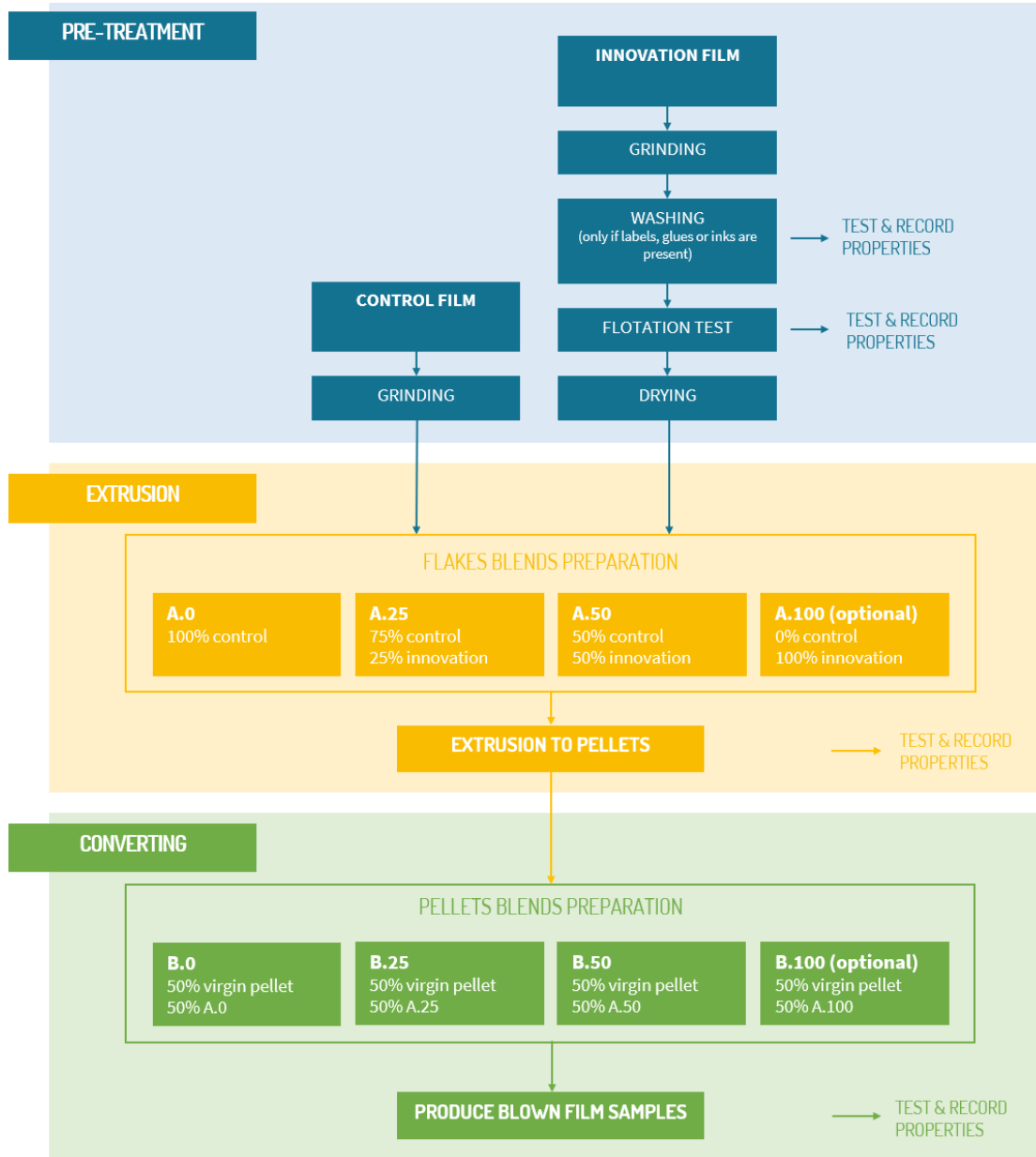


“Packaging solutions and/or innovations covered by the Protocols include: *resins, barrier materials, mineral fillers/additives, closure systems, liners, seals and valves, labels and sleeves, adhesives, and inks.*”

RecyClass

All protocols are available publicly at <https://recyclclass.eu/recyclability-evaluation-protocols/>. Visit our website!

Recyclability Protocol for PE films



- **Pre-treatment**

Input: 10 kg innovation and 25 kg control samples

- **Extrusion & pellet characterization**

Input: **3 blends** of control and innovation flakes (**with 0%, 0.25% and 50% of innovation**)

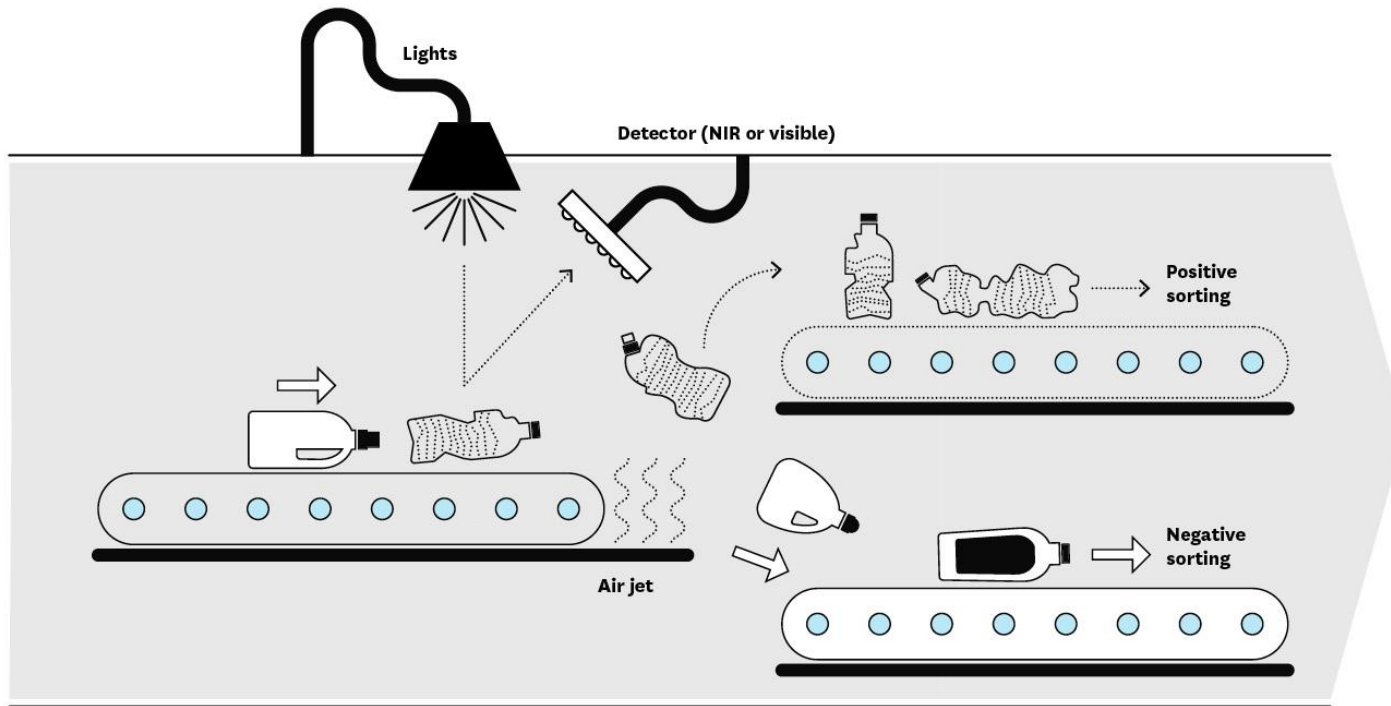
- **Conversion** (50% dilution with virgin)

Input: **3 blends** of control and innovation pellets (**with 0%, 12.5% and 25% of innovation**)

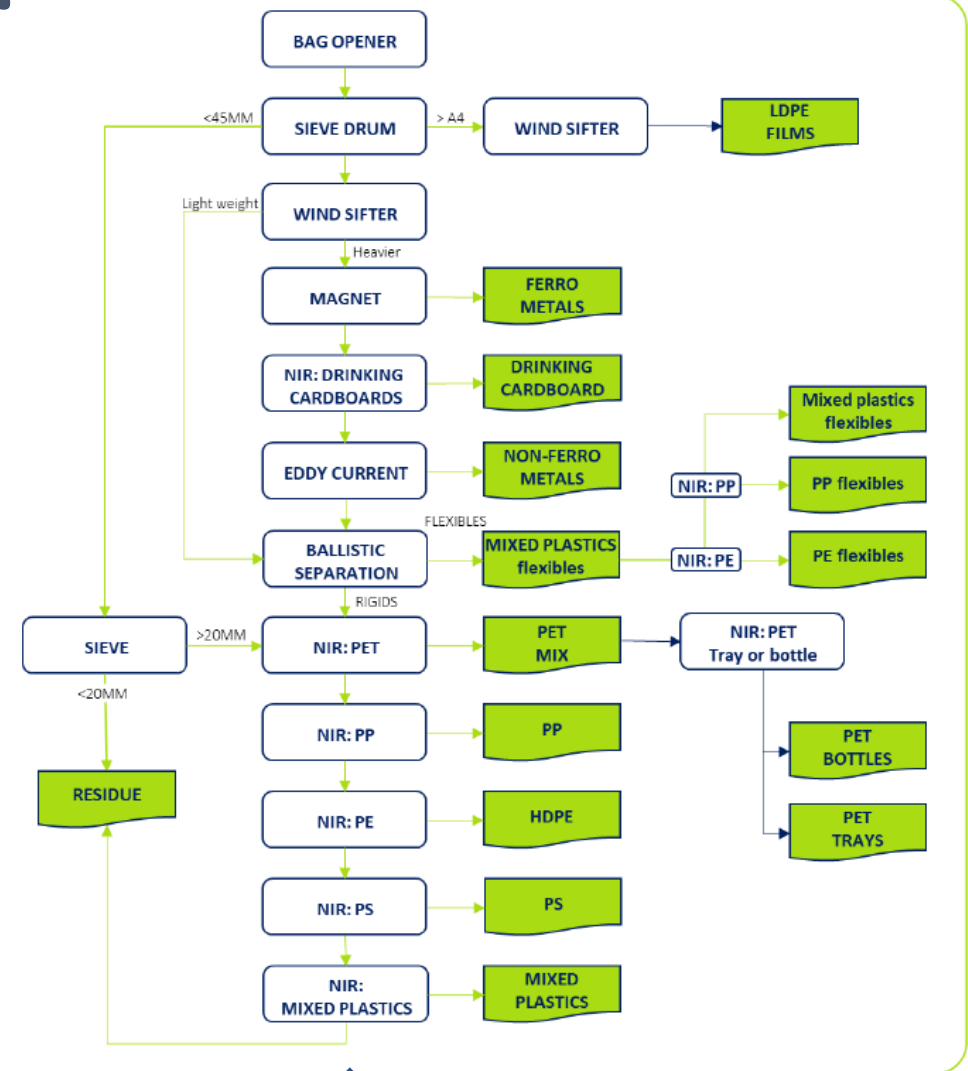
Recyclability Evaluation Protocols are conducted by accredited laboratories. List available at <https://recyclclass.eu/accredited-laboratories/> Visit our website!

Sorting is more than a NIR test!

Example of sorting process



RecyClass Sorting Protocol



RecyClass

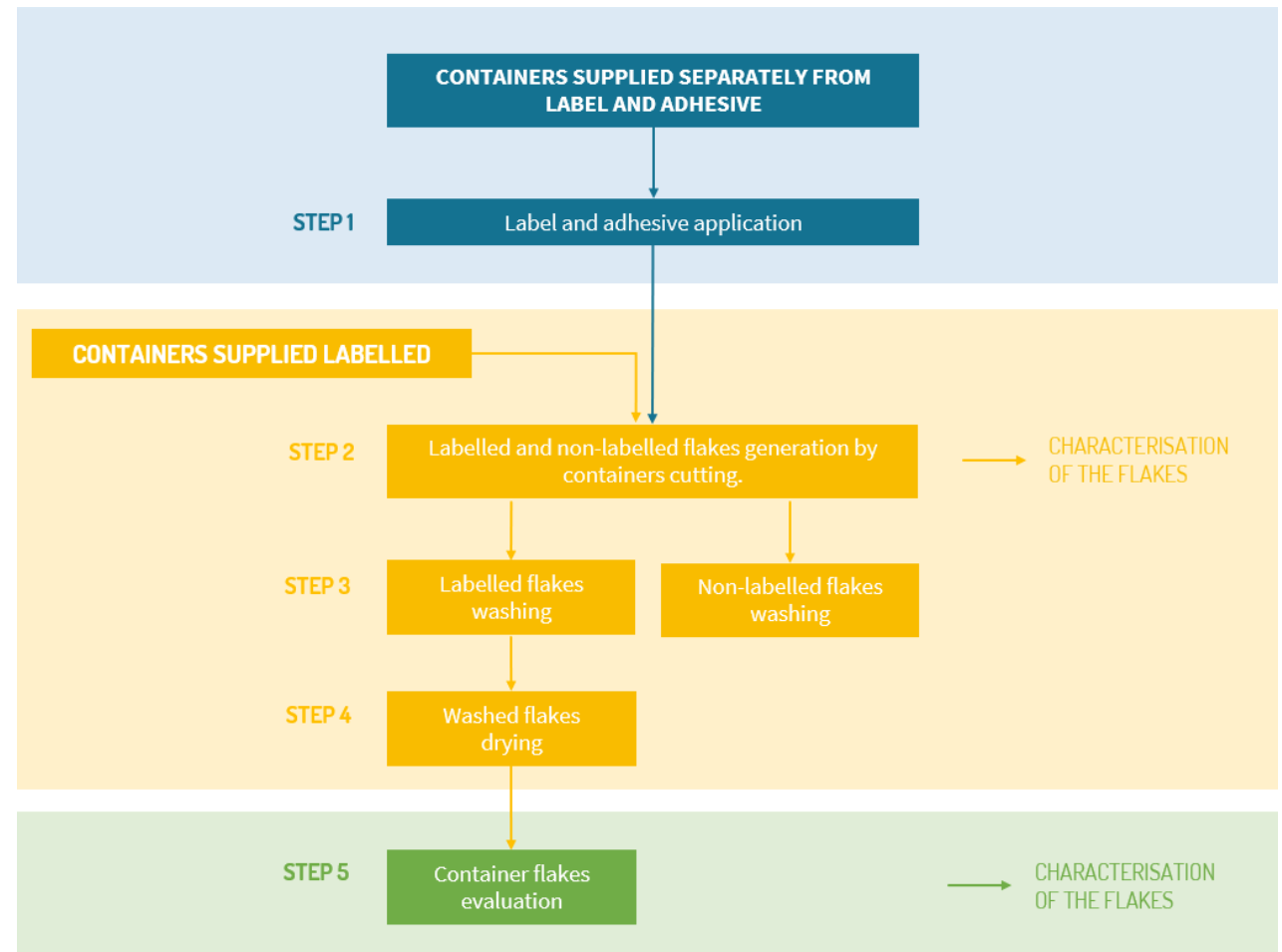
Main steps Main outputs

QT Procedures

The “Quick Test Procedures” describes the methodology that may be followed by the Applicant at a laboratory scale in order to determine if a specific packaging ingredient (for example adhesives, labels, inks, etc.) is compatible with recycling.

QT procedures provide guidance on the tests methodology that shall be followed, including benchmark recommendations to guide the interpretation of the results.

QT procedures may be carried out by the Certification Bodies to assess packaging features during audits.



Methodology diagram of the washing QT procedure for film labels applied on HDPE & PP containers

How to claim recyclability in 3 steps?

Design for Recycling
Guidelines



RecyClass
Tool



Recyclability Certification

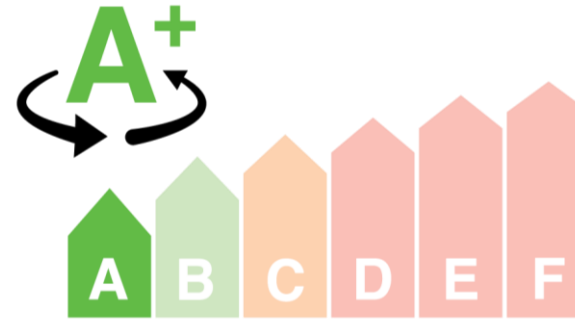
RecyClass PE TRANSPARENT FLEXIBLE FILMS for Household and Commercial Packaging

CLASS RANKING*	YES - FULL COMPATIBILITY A-B	CONDITIONAL - LIMITED COMPATIBILITY B-C	NO - LOW COMPATIBILITY D-E-F
DESCRIPTION (See Protocol)	Materials that passed the testing protocols with no negative impact OR materials that have not been tested (yet), but are known to be acceptable in PE recycling	Materials that passed the testing protocols if certain conditions are met OR materials that have not been tested (yet), but pose a low risk of interfering with PE recycling	Materials that failed the testing protocols OR materials that have not been tested (yet), but pose a high risk of interfering with PE recycling
MAIN MATERIAL	PE LD, PE LLD, PE HD	Multi-layer PE/PP	Any other polymer (i.e. PET, PVC, etc.)
NATURAL COMPOSITION	A when PE content is > 90% B when PE content is > 80%	C when PE content is > 70%	D when PE content is > 60% E when PE content is > 50%
COLOURS	Unpigmented, transparent	Light colours (transparent colour)	Dark colours (black, carbon black)
SIZE	> 40 x 10 x 50 mm once compacted	> 40 format or between 20 x 20 and 50 x 50 mm once compacted (starting test)	> 20 x 20 mm
PRODUCT RESIDUES (Easy to Empty index)	A if the index is < 5% B if the index is < 10%	C if the index is < 15%	D if the index is < 20% E if the index is < 25%
BARRIER	Barrier in the polymer matrix; SiO ₂ and AlO ₃ without additional coatings	> 5% EVOH (in polyolefin combination film); metalized layers without coatings; Eucalan High Plus (VCI-LDPE)	> 5% EVOH (in polyolefin combination film); barrier layer PVC, PBOC, PE, any other barrier agent; foaming agents used as expansion chemical agents, aluminium Nio (non-photodegradable additives) Additives that do increase the density higher than 0.91 g/cm ³ (CaCO ₃ , talc, glass fibers, etc.)
ADDITIVES	Additives that do not increase the density higher than 0.91 g/cm ³		
CLOSURE SYSTEM	PE LD, PE LLD, PE HD	PP	Metal, aluminium, PVC, PET, PETG, PE, PLA, non-PP or foams with density > 1 g/cm ³
LINEAR, SEALS AND VLVES	PE LD, PE LLD, PE HD	PP, removable aluminium lidings	Metal, aluminium, PVC, PET, PETG, PE, PLA, foiled paper, non-PP or foams with density > 1 g/cm ³
LABELS	PE	PP, paper labels without fibrous	Metalized labels, any other paper labels with fibrous
ADHESIVES FOR LABELS	Water soluble or water-releasable at less than 60°C		Adhesives non-soluble in water or non-releasable in water at less than 60°C
BMS	No inks	Non-toxic (according to EUPLA guidelines)	Inks that bleed; Toxic or hazardous inks.
DIRECT PRINTING	Label marked print; Printed production or expiry date	Printing covering > 50%**	Printing covering > 50%**
OTHER ATTACHMENTS	PE LD, PE LLD, PE HD	PP	Metal, aluminium, PVC, PET, PETG, PE, PLA, paper, foams with density > 1 g/cm ³
RECYCLED CONTENT			

No change in the recyclability assessment. A separate "Recycled Content Traceability Certification" based on a Chain of Custody approach is available with RecyClass

last update: February 2021

*Class ranking resulting from the RecyClass assessment. B class is reported two times because of the 30-60% amount of PE in the packaging or because of slight incompatibilities in the design.
**temporary solution



- Fact-based guidelines (Recyclability Evaluation Protocols)
- Give an **overview** of compatible and non-compatible packaging features

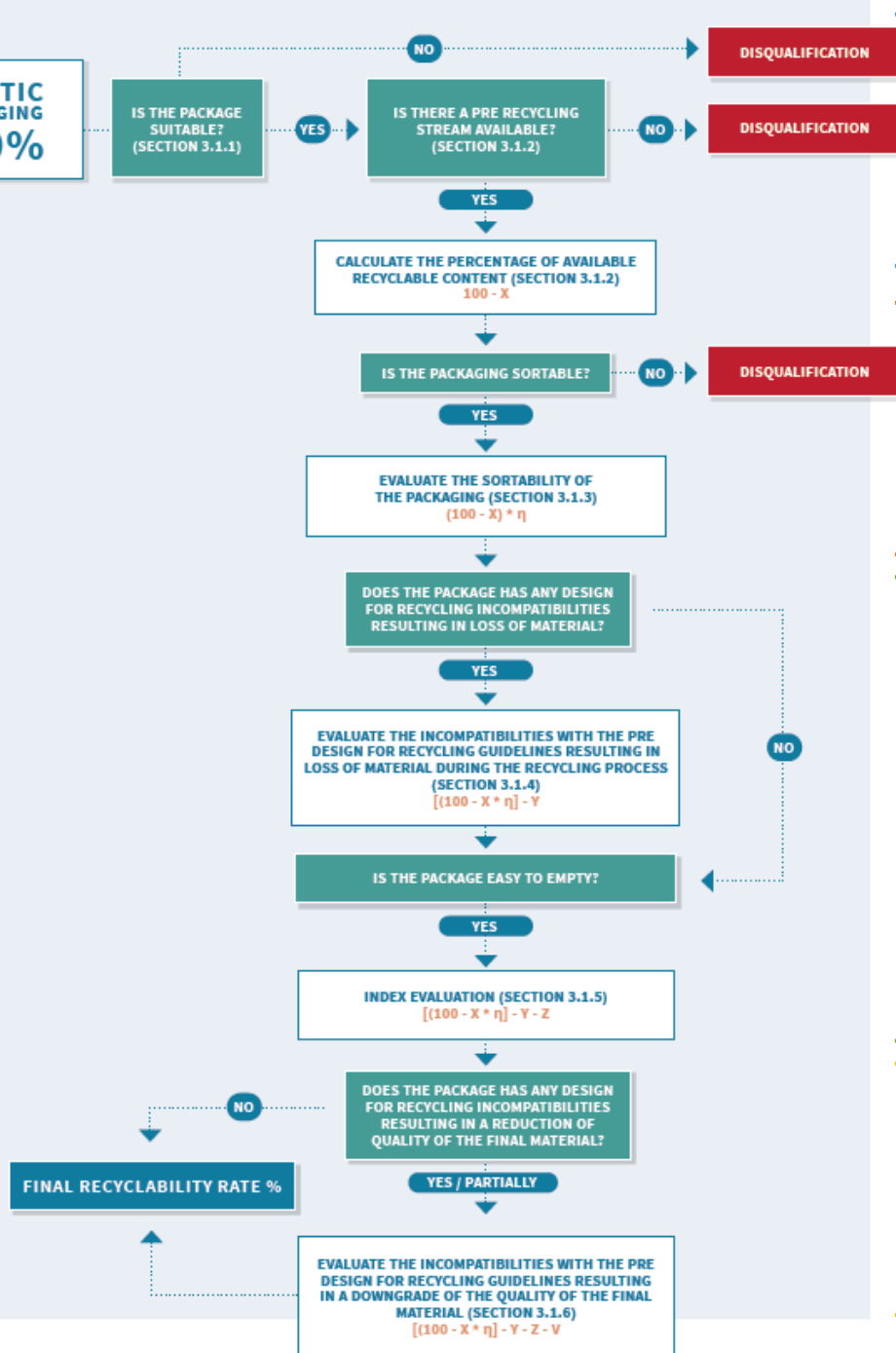
- Recyclability **Self-Assessment**
- RecyClass Team support

RecyClass



- Recyclability **Assessment** by recognized Certification Bodies

PLASTIC
PACKAGING
100%



Collection and local
infrastructure

Sortability

Recyclability (DfR)

End market: ability
in replacing virgin
plastic

RecyClass



COMPOSITION:

- PE POUCH 92,0%
- PP CAP 8,0%

ADDITIONAL INFORMATION:

- MULTILAYER PE WITH 5% EVOH BARRIER
- DIRECT PRINTING WITH CLEAR COLOUR 4%
- < 50% PRINTING COVERING
- NO LABEL OR OTHER ATTACHEMENTS

CLEAR PE POUCH

SUITABILITY:

It is made of more than 50% plastic
More than 50% of its surface is made of plastic
The pouch is not coupled with other materials
▷ $X = 0$; Interim result = $(100 - X) = 100\%$

COLLECTION:

PRE recycling stream exists (PE)
▷ Interim result = $(100 - X) = 100\%$

SORTABILITY:

No carbon black surface, No Al layer > 5 microns, PE Multilayers, Clear colour
Sorting test with the Sorting Protocol to identify where the pouch will end and the sorting efficiency
Assuming tests confirmed it is sorted in the PE flexible stream with $\eta_{\text{sort}} > 70\% \rightarrow \eta_{\text{sort}} = 1$
▷ Interim result = $(100 - X) * \eta_{\text{sort}} = 100\%$

DFR COMPATIBILITY:

No disqualifying items
No elements separated by the process (the PP cap will float as well as the PE flakes)
▷ $Y = 0$ Interim result = $[(100 - X) * \eta_{\text{sort}}] - Y = 100\%$

EASY TO EMPTY:

The pouch will be almost completed emptied after use (Index < 5)
▷ $Z = 0$ Interim result = $[(100 - X) * \eta_{\text{sort}}] - Y - Z = 100\%$

REPLACE VIRGIN PLASTIC:

EVOH will affect the recylate quality (if $\leq 5\%$ -> -5% should be applied)
Laminating adhesive is 3% (-3% to be applied, assuming its chemical formulation doesn't affect the recycled plastic quality)
PP cap will affect the recycled plastics quality (PO mix \rightarrow -25%)
Direct printing will affect the recycled plastic quality as this is a clear pouch (i.e. -15%)
▷ $V = 48$ Final result = $[(100 - X) * \eta_{\text{sort}}] - Y - Z - V = 52\%$ (Class C)



RecyClass solutions:

1. NEW MATERIALS

Laboratory test

1A. Recyclability Evaluation Protocols

Laboratory assessment of the **reprocessability** of new materials or material combinations.

Results can be submitted for RecyClass Technology Approval.

Validation of technology

1B. Technology Approval

Validation of a **specific technology** (e.g. functional barrier, adhesive, etc.) with a determined recycling stream. The **lab results** are assessed by the RecyClass **Technical Committees**.

Validation of features

1C. Product Approvals

Validates the **compatibility** of a **final packaging** (as commercialized) with a determined recycling stream. Mainly **meant for packaging containing new features** which are not yet covered by the guidelines. Assessed by the **Technical Committees**.

A Technology Approval and a Product Approval will lead to integration in the design for recycling guidelines (3A), the RecyClass online tool (3B), and the Recyclability product certification (3C).

3. FINAL PACKAGING

Design help

3A. Design for Recycling Guidelines

Insights on how to **improve** the recyclability of a packaging. Material combinations, components, etc.

Self assessment

3B. Online tool

Self assessment: quick scan to check the **theoretical recyclability** of your packaging

External verification

3C. Recyclability Product Certification

Official **external assessment** of recyclability. Based on RecyClass Design for Recycling **Guidelines** and operational **sorting tests**.

3C-A. Design for Recycling Assessment:

It classifies the technical recyclability of a plastic packaging on the **EU market**.

3C-B. Recyclability Rate Assessment:

It classifies and rates the technical recyclability of a plastic packaging in a **specific country** for which the assessment is conducted.

2. SEMI-FINISHED PACKAGING

External verification

2A. Letter-of-Compliance

Official **external assessment** of recyclability of a **semi-finished packaging**. Assessment is based on RecyClass Design for Recycling **Guidelines** and operational **sorting tests**.

It classifies the technical recyclability of a semi-finished plastic packaging on the **EU market**.

Packaging companies typically like an assessment on a semi-finished packaging and are looking for a Letter-of-Compliance. Brand owners will turn the semi-finished packaging into a final packaging (3) by adding product, print, labels, etc.

The resulting score for of the semi-finished packaging is typically the maximum possible score of the final packaging. The score provides a good indication of sorting behaviour and reprocessability.

4. RECYCLED CONTENT

Methodology

4A. Recycled Content Audit Scheme

Methodology to evaluate and calculate the recycled content used in plastics.

Verification by auditing

4B. Recycled Content Traceability Certification

The Certification is granted based on the Audit Scheme requirements (3A). The Certification is granted after the auditor successfully carries out the on-site audit.

5. MARKETING TOOL

Visual Communication

5A. RecyClass Logos

Certified companies are allowed to use the RecyClass logos, dependently of the certification(s) they achieved. The logo can be used for marketing purposes and printed on the packaging.

Written Communication

5B. Use of Claims Guidance

RecyClass defined a **list of endorsed claims** that can use by the certified companies to communicate externally in an appropriate and transparent way about their certifications.



The background of the entire image is a dense, close-up photograph of various pieces of discarded plastic waste. This includes clear plastic bottles, white plastic containers, and crumpled plastic bags. The image has a light blue color overlay. In the center, there is a large, solid orange circle that serves as a backdrop for the text.

**Thank you
for your attention**

www.recyclclass.eu

fabrizio.digregorio@plasticsrecyclers.eu

RecyClass

RecyClass Unwrapped: Scientific testing with RecyClass - Protocols explained

Design protocol for sorting evaluation of household waste packaging

Date: 28/04/2021

NTCP: Freek van Rhijn, Project Manager



Who?

The National Testcenter for Circular Plastics in Heerenveen was established in 2018 bridging the gap between industry and academia. NTCP is a not-for-profit organization that facilitates and accelerates the development of industrial sorting of different plastic streams from municipal (and in the future company) waste by providing industry-scale testing facilities, such as test and R&D platforms for sorting, detection and washing, and expertise, through innovation programs open to market.



NTCP is a not-for-profit organization

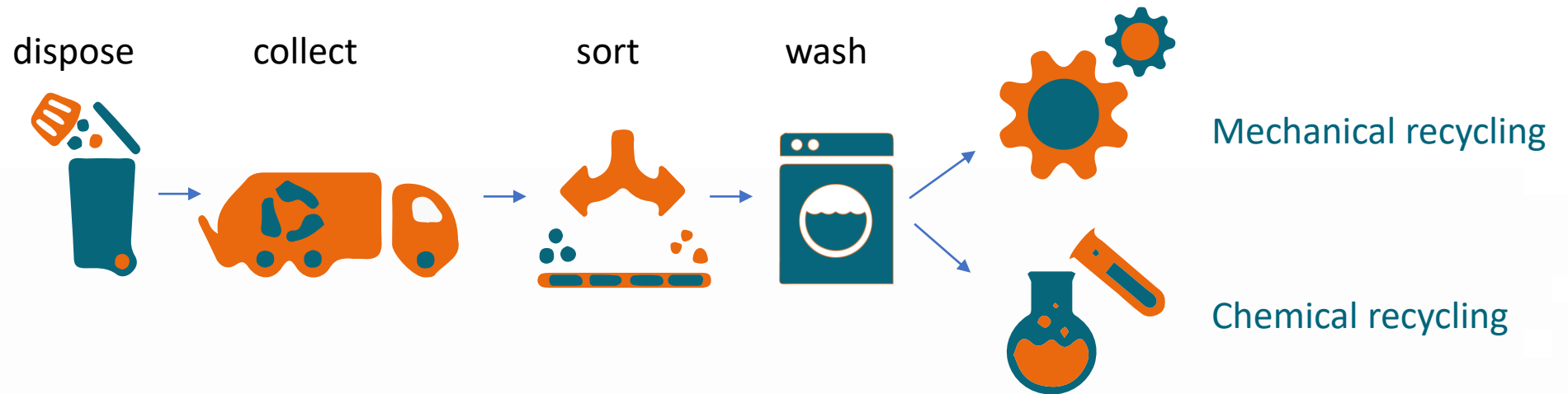


Independent, open to all players in recycling chain

NTCP nationaal testcentrum
circulaire plastics

Why?

The volume of plastic recycling should increase. Our objective is to work towards complete reuse of plastic streams from household (and company) waste to be applied for the originally intended use (i.e. packaging to packaging), decreasing downcycling of (potentially) valuable streams focusing on sorting and washing. We will do this by means of testing and facilitating the development and innovation within the complete valuechain. Sorting and washing are key conditions for the different recycling routes (mechanical and chemical recycling)



Source: Ellen McArthur
foundation

What?

- Controlled sorting tests using real waste streams, preparation of sample streams for recycling tests
- Optimising the sorting processes of existing facilities or equipment
- Facilitate technology development
- Structured data collection, storage, analysis and reporting
- Joint research programmes and contract research



**Assessment and validation of
newly designed products**



**Accelerate technological
innovations**



**Data-driven, results available in
knowledge database**

Why? standardized sorting protocols

“Alignment of package evaluation to a standard which deliver repetitive results!”

“Elimination of variability (or know where the differences are)”

“Strong basis to start improvement loop”

“Aligned to industry standard”

“Make sure to compare apples to apples!”

How? standardized sorting protocols

Close collaboration

Data driven

Pragmatic

Controlled environment

Package evaluation & feedback

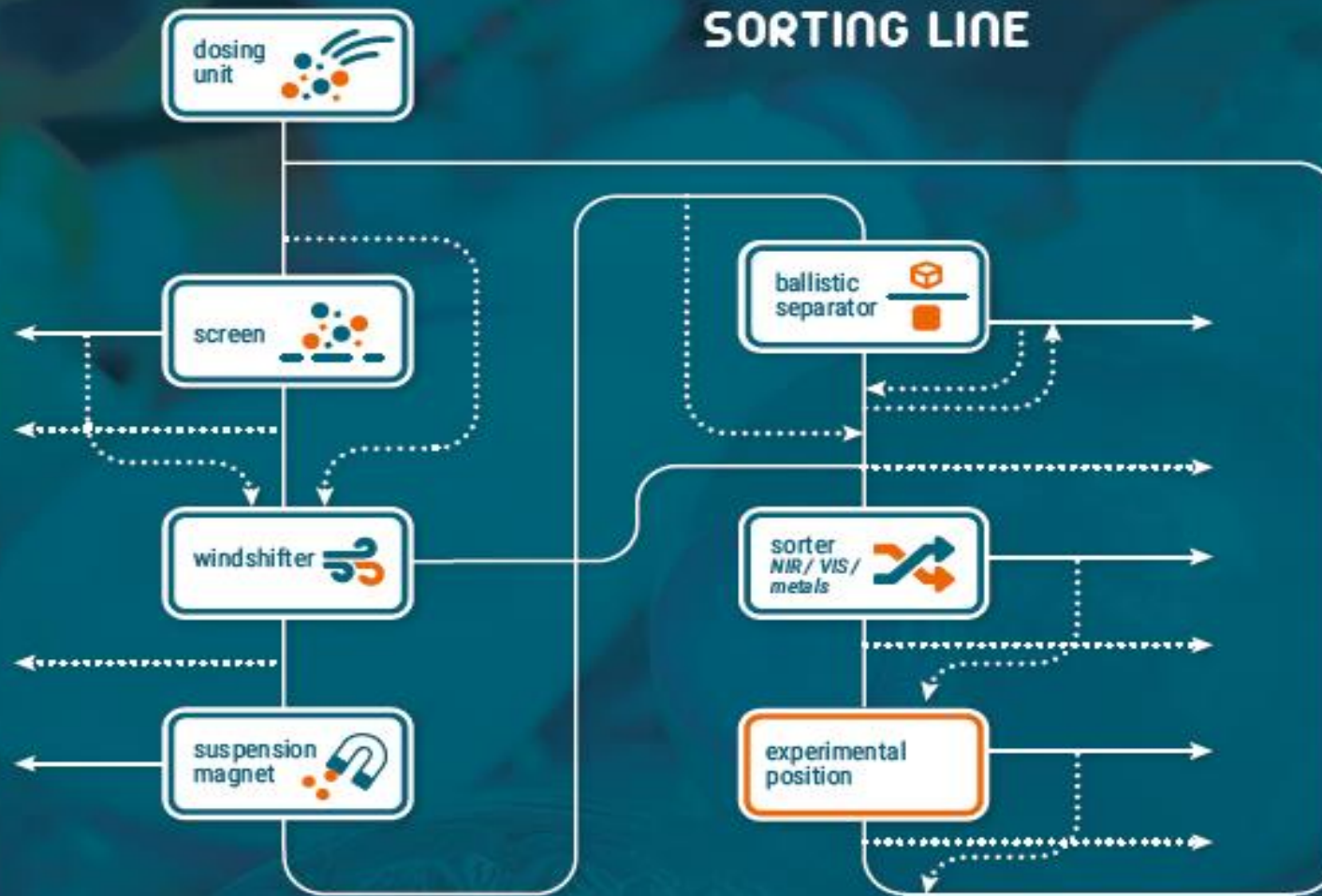
Industry standard



RecyClass

NTCP
national test centre
circular plastics

SORTING LINE



The NTCP pilotplant:

Modular design

- Each sorting step can be executed and sampled individually
- Each sorting step in the line can be by-passed

Experimental position for new equipment/technologies

Pilot scale washing line will be realised late 2020





Dosing unit



Optical sorter with vis and non-ferro

Robot



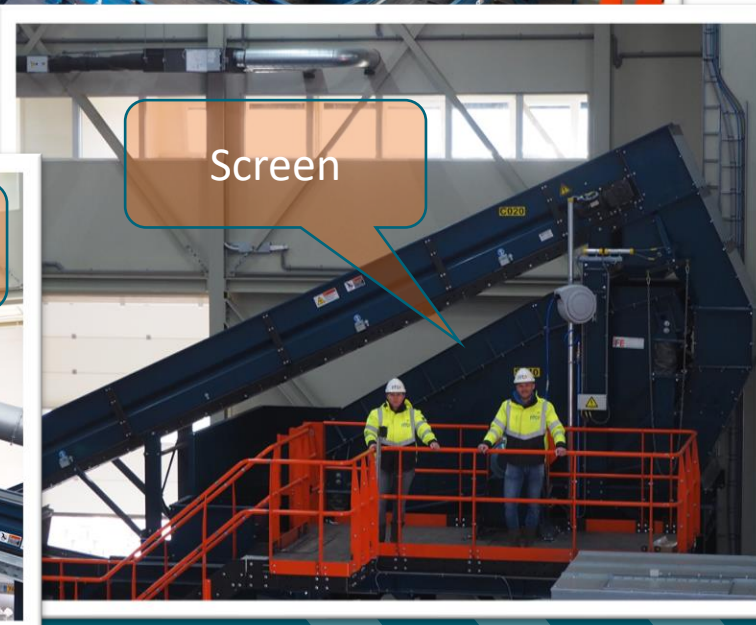
Ballistic separator



Windshifter



Magnet



Screen

Important elements of sorting protocol

1: Sample preparation (representative of being used, disposed and collected entering the recycling loop)

- Standardized protocol to determine product left over (RECYCLASS)
- Standard Contamination and Compression protocol (NTCP powered by KIDV)

2: Test protocol alignment

Use the standardized NTCP sorting process protocol

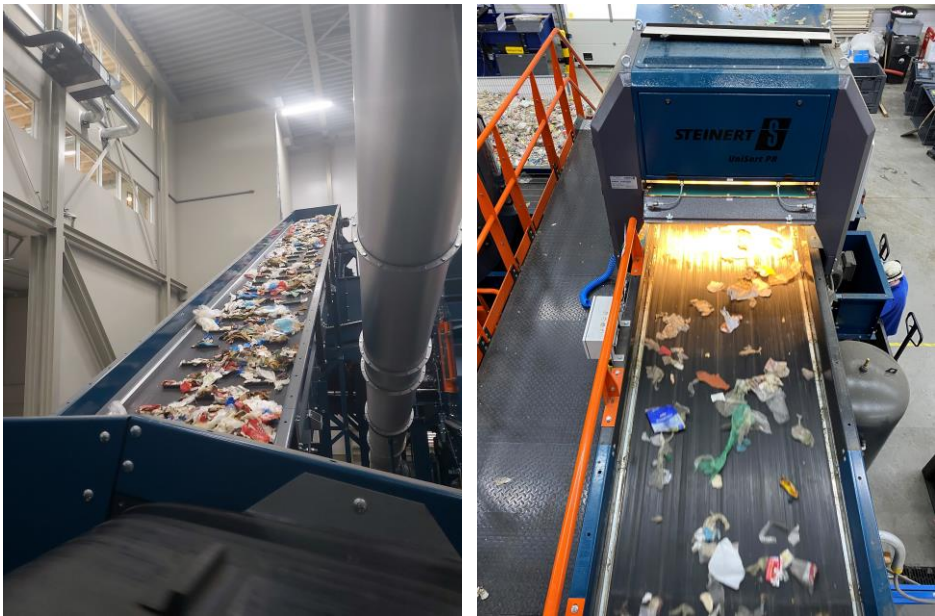
3: Protocol set up

Sorting evaluation over complete sorting process as individual sorting steps.

4: Industry standard

The material will be fed into the line and then looped imitating an industrial plant which runs on a throughput of 2Tkg/hr throughput. This is a calculated throughput based on the conveyor speeds and dimensions.

Protocol set up: Sample selection based on CIRCPACK data

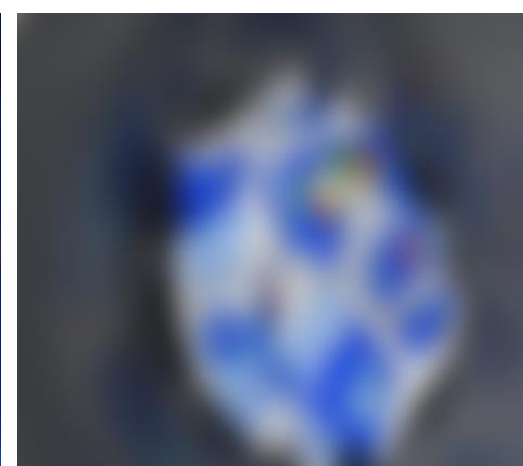
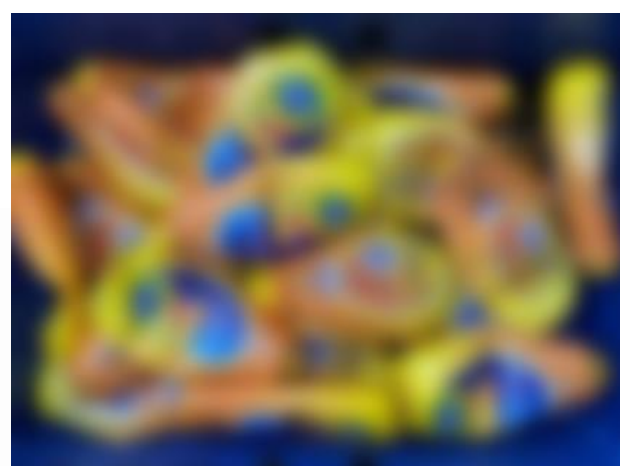
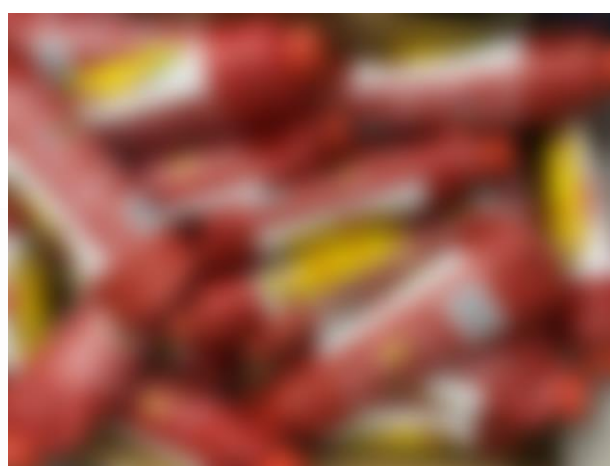
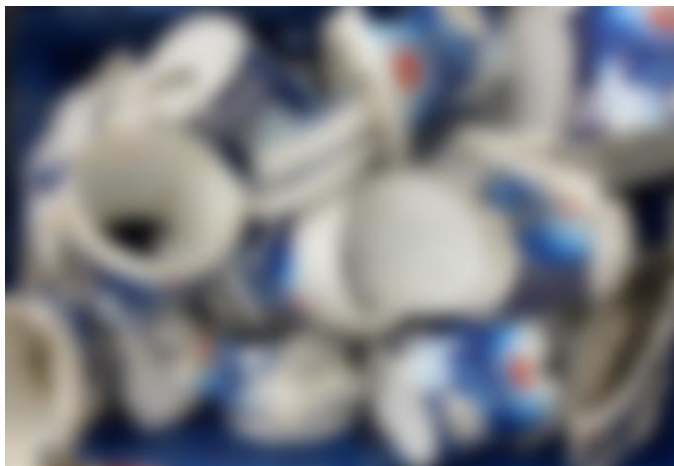
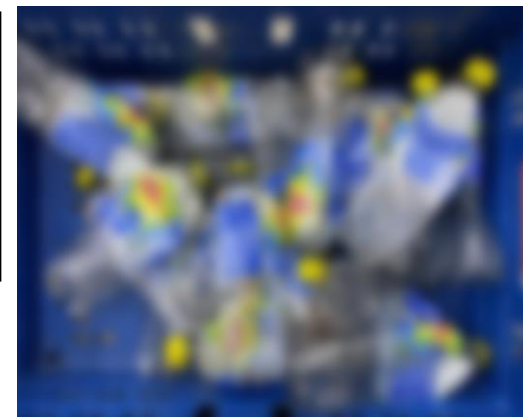


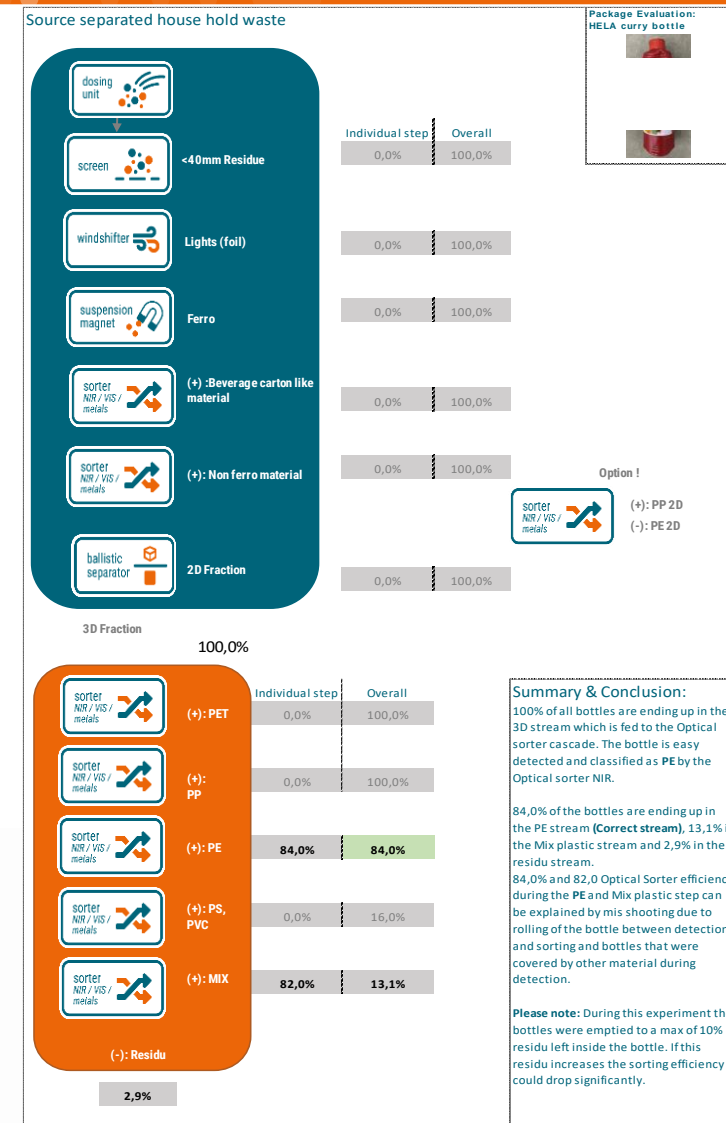
	Output stream	Circpack code	Package description	Photo
1.	Flexibles	20000000	<div></div>	
2.	Mix	8		
3.	PP	2		
4.	PE	4		
5.	PET	8		

Sample Preparation

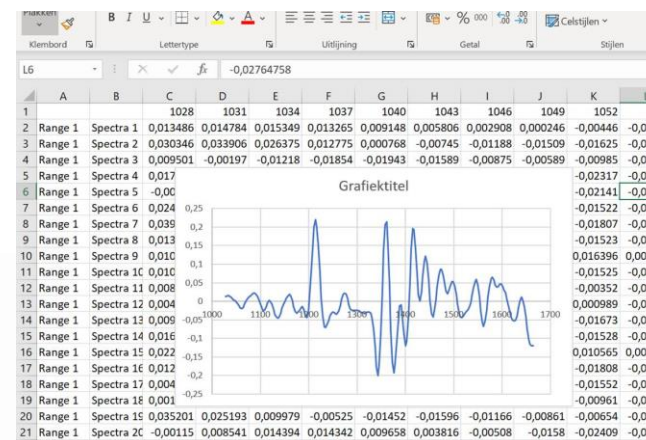
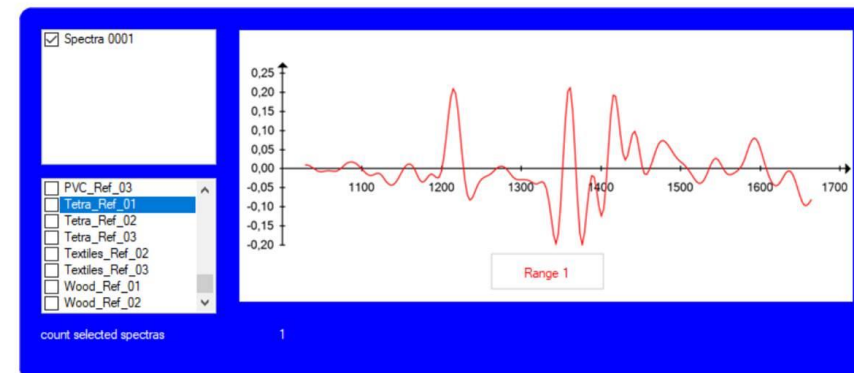
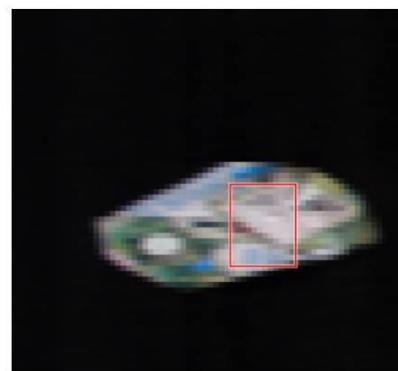
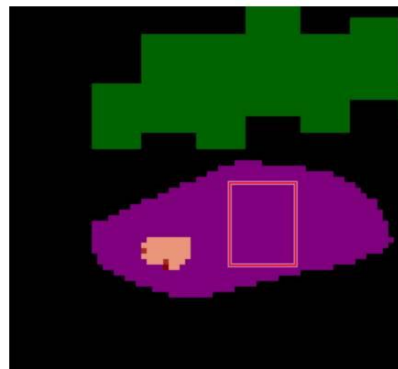


Samples are prepared by the NTCP standard contamination and compression protocol. Samples are contaminated by its own product and the use of a mix of other material (mainly organics) retrieved from a waste handler. By mixing and duration a representative sample is created compared with packages you can find at a waste handler after use and disposal process. After contamination, the samples are compressed by a modified compressor reflecting the reality after being compressed inside a waste truck.





NTCP: Optical Sorter Package evaluation



Next steps:

- Define RECYCLASS acceptance criteria
- Advice to find a upper/lower limit on sorting outcome by setting testing to reflect all different industrial sorting centres.
- Consumer disposal process should be part of sample preparation process(product residue can have a huge influence on sorting process)
- NTCP Sorting trials will consist of:
 - Consumer disposal process
 - Compression and Contamination protocol
 - Optical Sorter package evaluation
 - Sorting trial

RecyClass webinar

The role of protocols in product development

April 2021



Who We Are

We are a global manufacturer of self adhesive labels and packaging solutions and are providing a substantial amount of labels all over Europe via printing companies and label converters to customers in every major industry.

Material science is in our DNA - we do not just produce self adhesive labels - we also invest in research and design.

Corporate headquarters in
Glendale, California

Operations in more than
50 countries

Number of employees worldwide
More than 30,000

Sales in 2019
\$7.1 billion

Fortune rank as of
the end of 2019
427

Our Businesses at a Glance | 2019 Sales

\$4.7 bil.

Label and Graphic Materials

- Label and Packaging Materials
- Graphics Solutions
- Reflective Solutions



\$1.7 bil.

Retail Branding and Information Solutions

- Tickets, Tags, Labels, and Embellishments for Retail Apparel
- Radio-Frequency Identification
- Printer Solutions

\$674 mil.

Industrial and Healthcare Materials

- Performance Tapes
- Adhesives
- Fastener Solutions
- Medical Solutions



Global Coverage

7 R&D Centers and 400+ Scientists

- Netherlands
- Switzerland
- United States of America (2)
- Brazil
- China
- India

Where is Avery Dennison active



Industry Associations



Supplier paper/film
Supplies face stock and backing liner



Avery Dennison
Brings together top coat, face, adhesive and liner for the label construction



Converter
Printing and die cutting



End user
Applies the label to the container



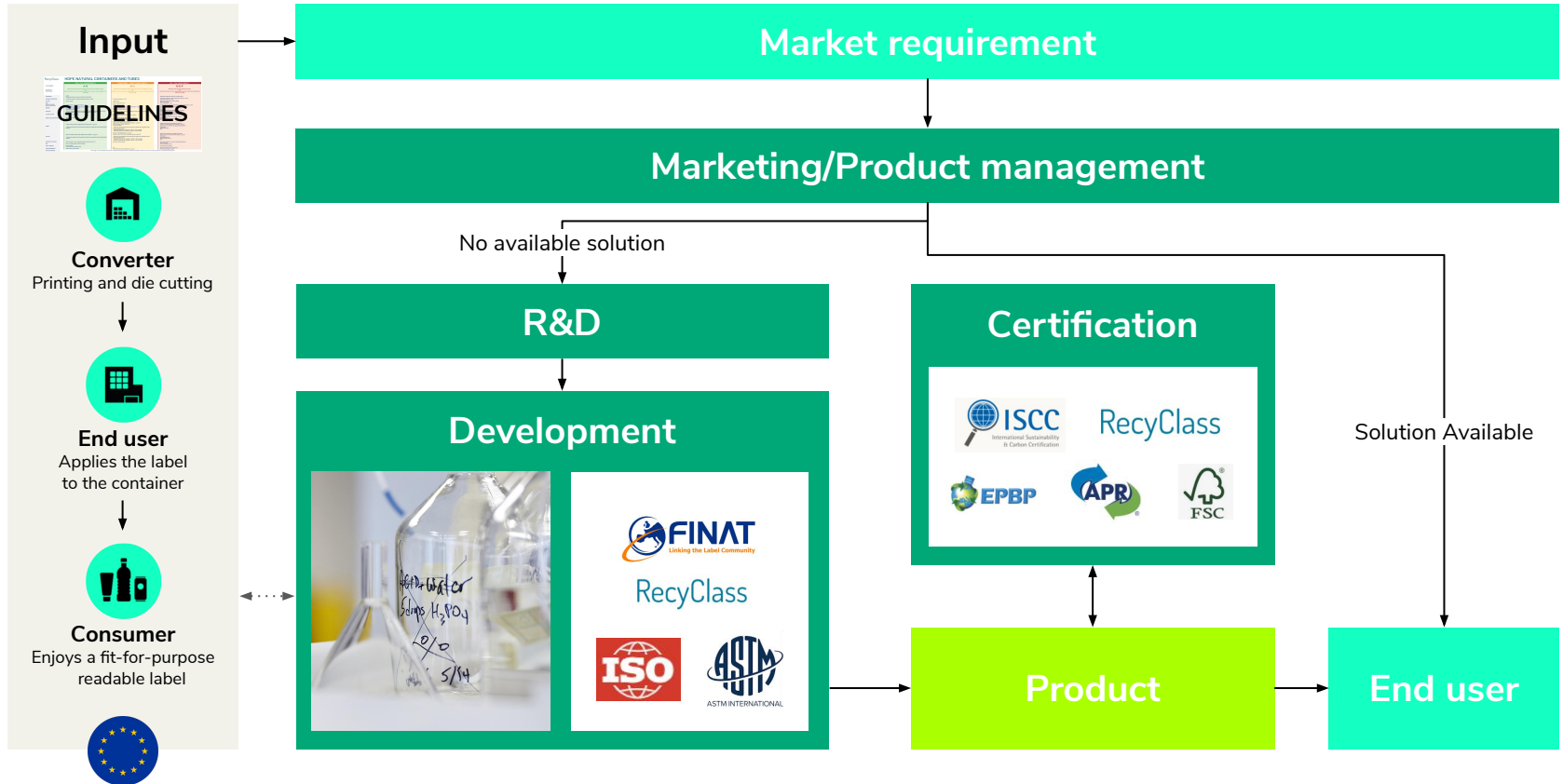
Consumer
Enjoys a fit-for-purpose readable label

NGO Cooperation



Barron's top 100 sustainable companies

New Product Development



Use of Protocols

Protocols - Quick tests

- Guidelines need to be taken into account
- Protocols are important for R&D:
 - Development and Validation of prototypes
 - “Easy” and **quick** to perform - represent performance in industrial process
 - Use of standard laboratory equipment
 - Relative small amount of prototype

Protocols/Methodology - Certification

- Used at pilot testing/independent certified institutes
- Require specialised equipment
- Reflect the industrial process and evaluated the output



Harmonisation

Guidelines

- Build Framework
- Customer education
 - Label design
 - Sorting
 - Ecodesign

Protocols/Methodology

- Used in product development
- Providing clarity to industry
- Easy Accessible

Harmonisation

- Providing clarity to customers
- Reducing time to market
- Reducing costs of certification



Thank you



RecyClass

RecyClass Unwrapped

Questions & Answers session

Use the Q&A box in the top-right corner of your screen





Thank you for participating!

Next webinars:

26 May 2021: Plastic packaging decorations

23 June 2021: Recyclability of personal care packaging

We kindly ask you to fill in the [webinar evaluation form](#).