THE FUTURE OF PLASTIC RECYCLING

UPGRADE POST-CONSUMER PLASTIC: MATERIAL AND COLOR SORTING

TOMRA SORTING SOLUTIONS | RECYCLING

László Székely
Plastic Recycling in Reality
Ystad, 09. May 2019

CONTENT

- Who is TOMRA?
- Detection and sorting technologies.
- Plastics - facts and figures.
- High quality recycling.
- Design for recycling.
- Summary.

4000+
EMPLOYEES GLOBALLY

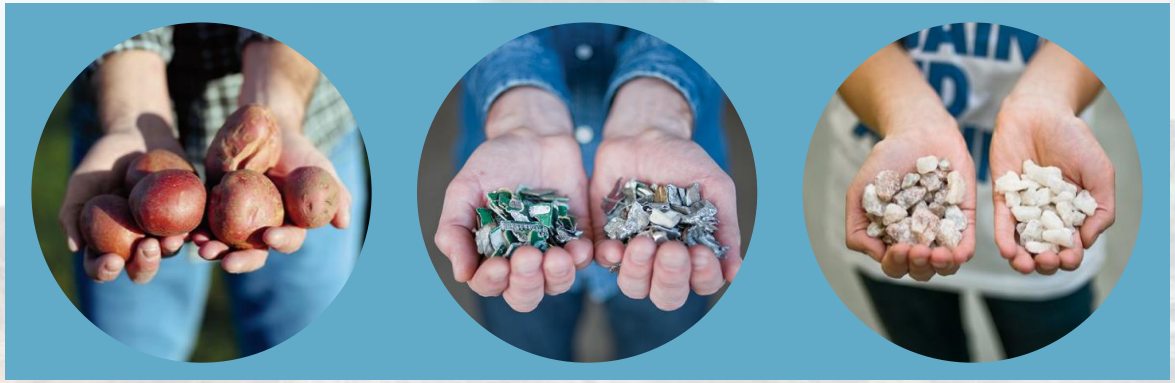
Publicly listed on Oslo Stock Exchange (OSEBX: TOM)

8.6
BILLION NOK REVENUES IN 2018

TOMRA

TOMRA SORTING SOLUTIONS

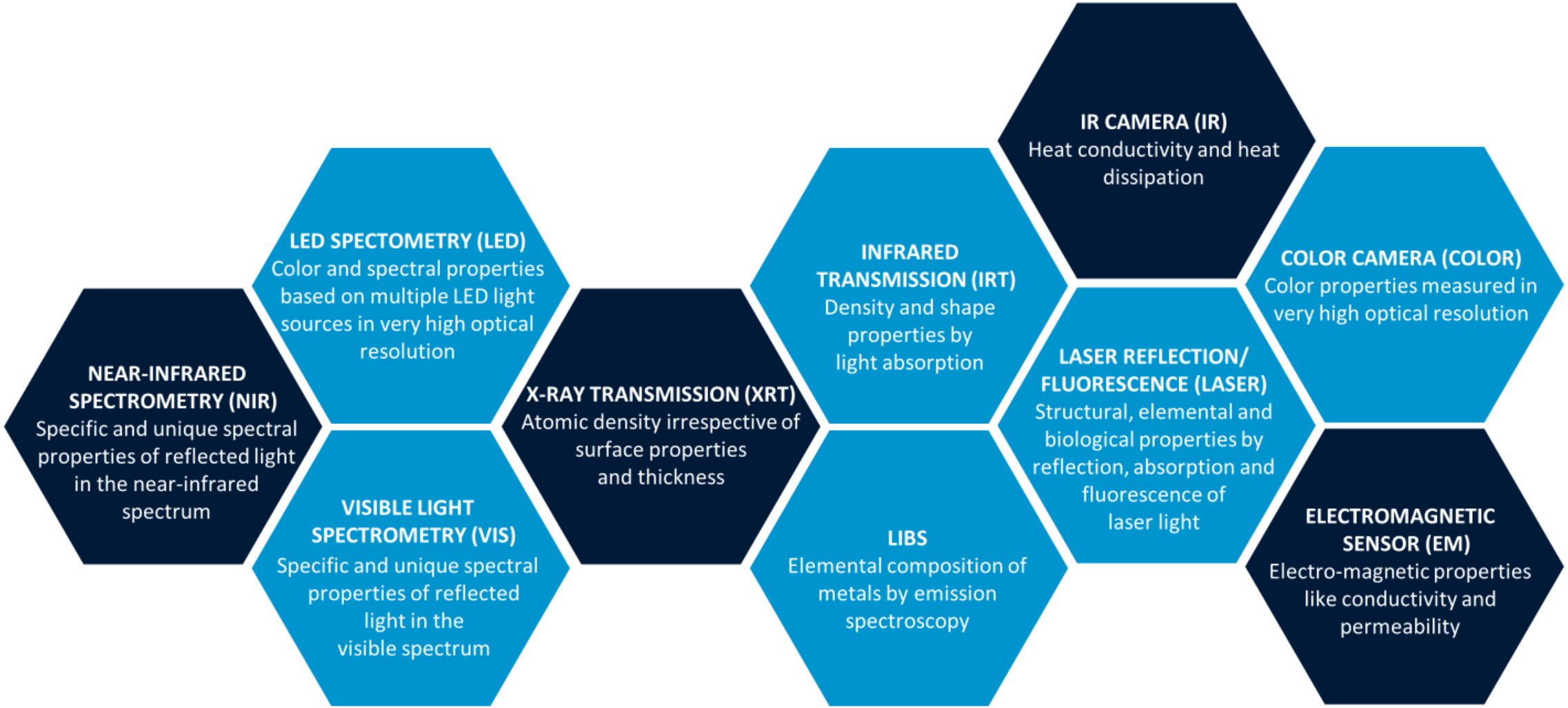
TOMRA COLLECTION SOLUTIONS



FOOD | RECYCLING | MINING | REVERSE VENDING | MATERIAL RECOVERY

Circular Economy

BROAD SENSOR PORTFOLIO



INSTALLED SORTING SYSTEMS WORLDWIDE

WE SUPPORT CUSTOMERS ON ALL CONTINENTS

FOOD Install base	EMEA ~ 3.535	Americas ~ 3.540	Asia ~ 600	Other ~ 555	**Total ~ 8.230**
RECYCLING Install base	EMEA ~ 3.850	Americas ~ 800	Asia ~ 700	Other ~ 20	**Total ~ 5.370**
MINING Install base	EMEA ~ 60	US/Canada ~ 35	Australia ~ 5	Other ~ 40	**Total ~ 140**

SENSOR-BASED SORTING SYSTEMS – RECYCLING

AUTOSORT
- FLYING BEAM®: continuous signal correction, integrated light source, enhanced light distribution
- flexible sensor configuration (NIR/VIS/EM)
- optimized sensor system

AUTOSORT *FLAKE*
- Simultaneous material, metal and color detection
- FLYING BEAM®: continuous signal correction, integrated light source, enhanced light distribution
- highest available sensor resolution
- optimized sensor system

AUTOSORT *LASER*
- Independent background system
- Simultaneous single-point detection
- Glass vs. transparent polymer recognition
- Fully flexible sensor configuration
- Unique mechanical design built for highest safety standards

COMBISENSE
- FLUID COOL®
- dual processing technology
- auto-adjustable ejection module

COMBISENSE *CHUTE*
- FLUID COOL®
- dual processing technology
- simultaneous single-point detection
- double-sided detection

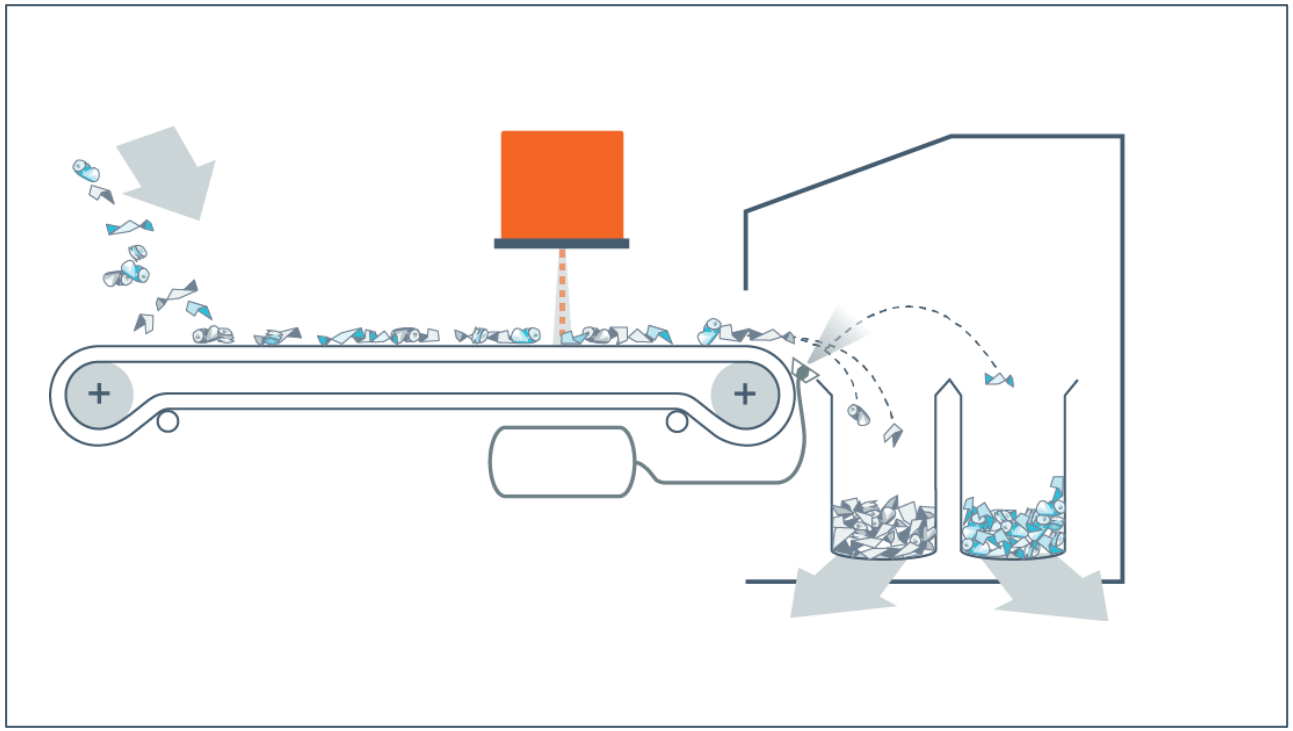
FINDER
- SUPPIXX® technology
- Z-TECT technology
- IOR technology

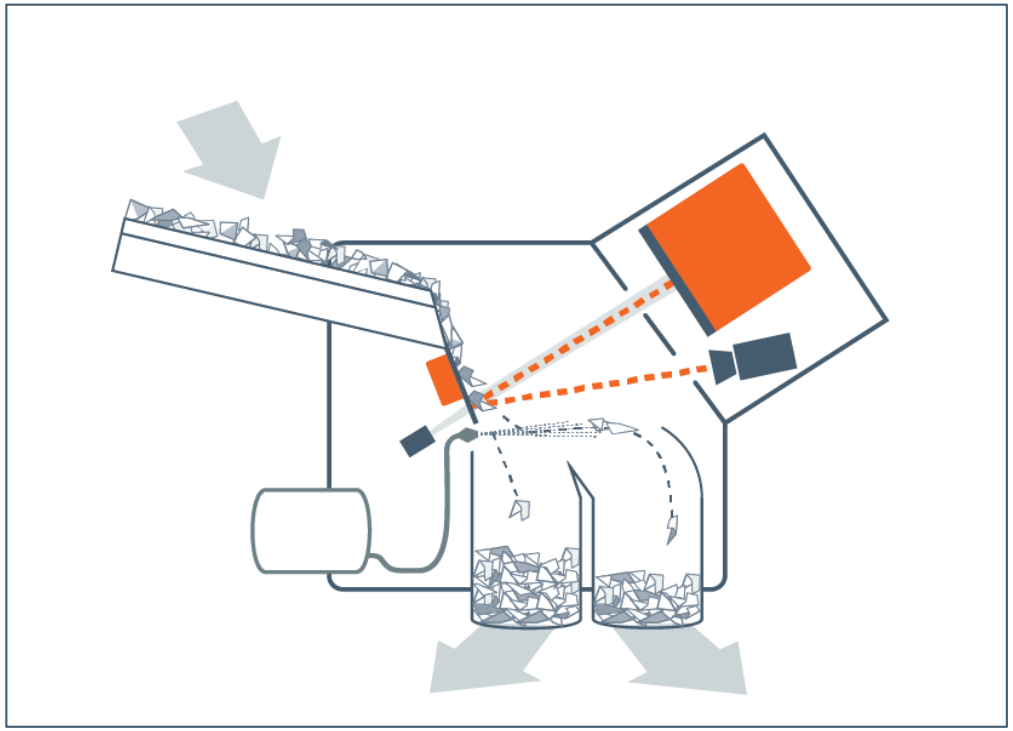
X-TRACT
- Dual processing technology
- Highest quality of secondary material in metal applications
- largest installed base worldwide

AUTOSORT/FINDER with LOD Feature
- Equipment upgrade with minimal initial investment
- Independent background system

SENSOR-BASED SORTING – OPERATING PRINCIPLE

SENSOR-BASED SORTING – OPERATING PRINCIPLE





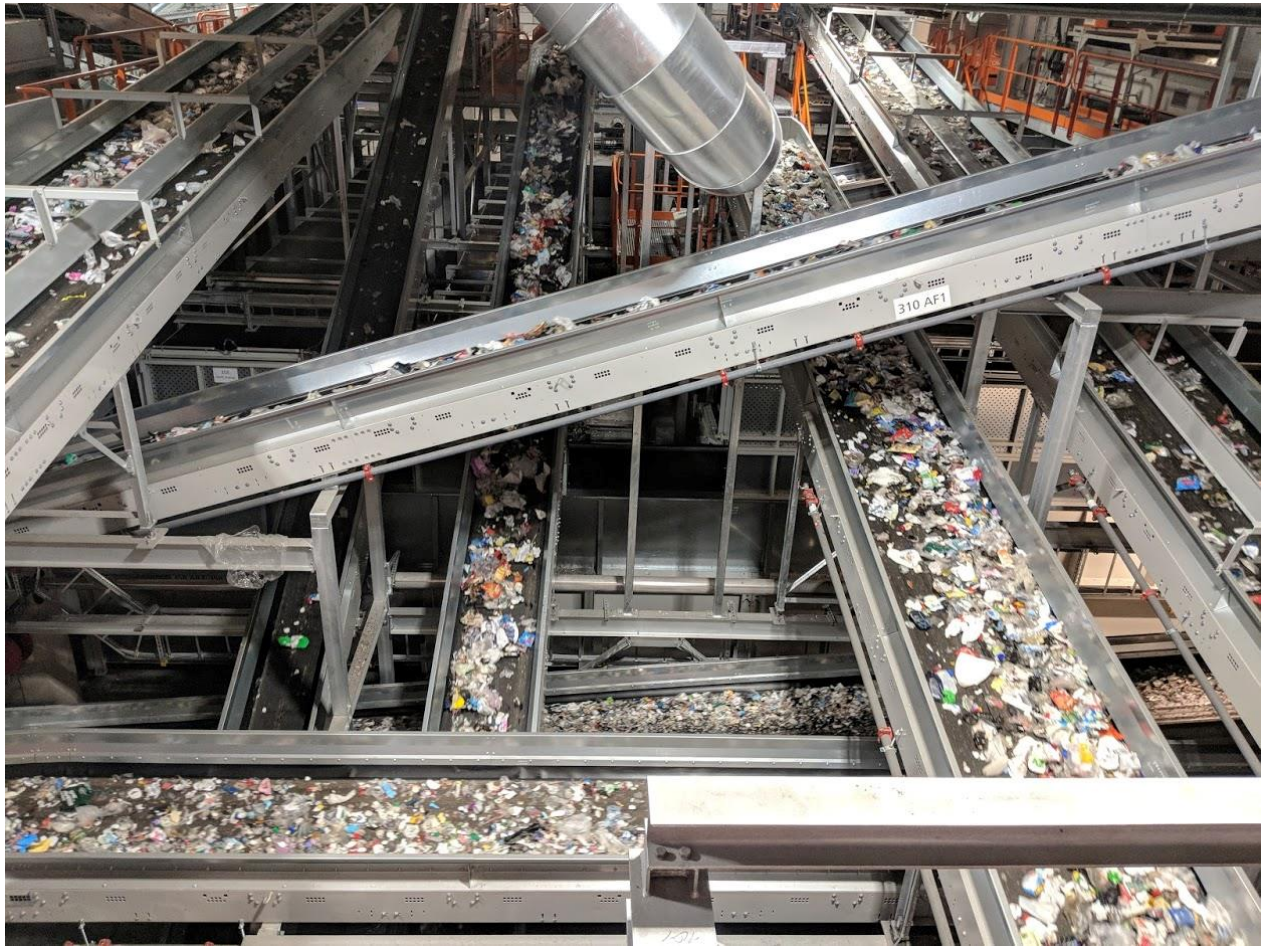
- High-tech sensors to identify objects on a transport system.
- High speed processing of information (material, size, color, shape and position of objects).
- Precise sorting by air jets.
- Product specific equipment design often including multiple technologies to maximize sorting efficiency.

FIELD OF ACTIVITY – EXAMPLES OF SORTING PLANTS

Romerike, Norway

- Municipal solid waste (MSW): 40 t/h
- 16 Sensor based sorting systems (NIR)
- Sorted products:
  - PE Film
  - PET
  - HDPE
  - PP
  - Mixed Plastics
  - Mixed Paper
  - Metals (Fe/NFe)
  - Organic

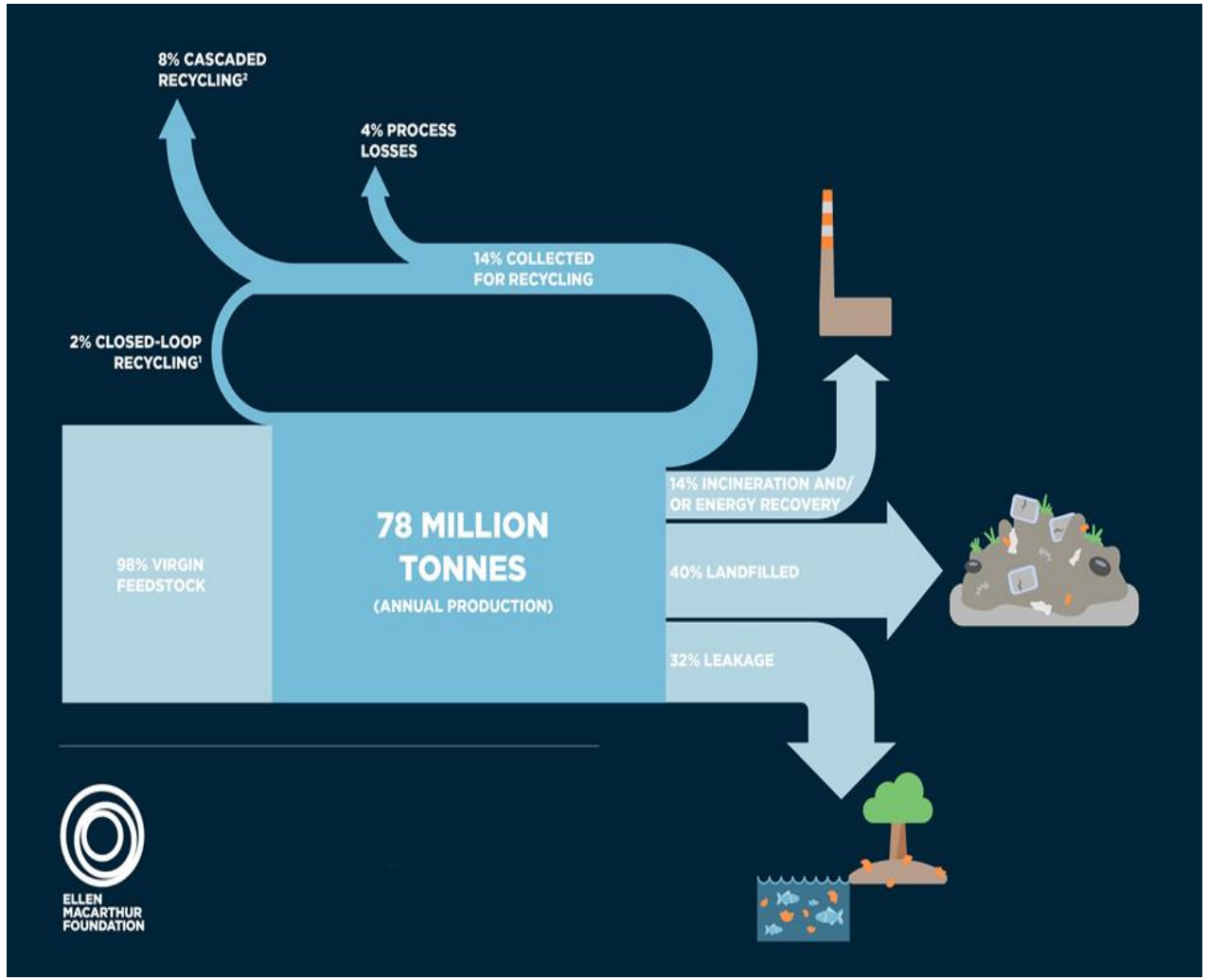
FIELD OF ACTIVITY – EXAMPLES OF SORTING PLANTS

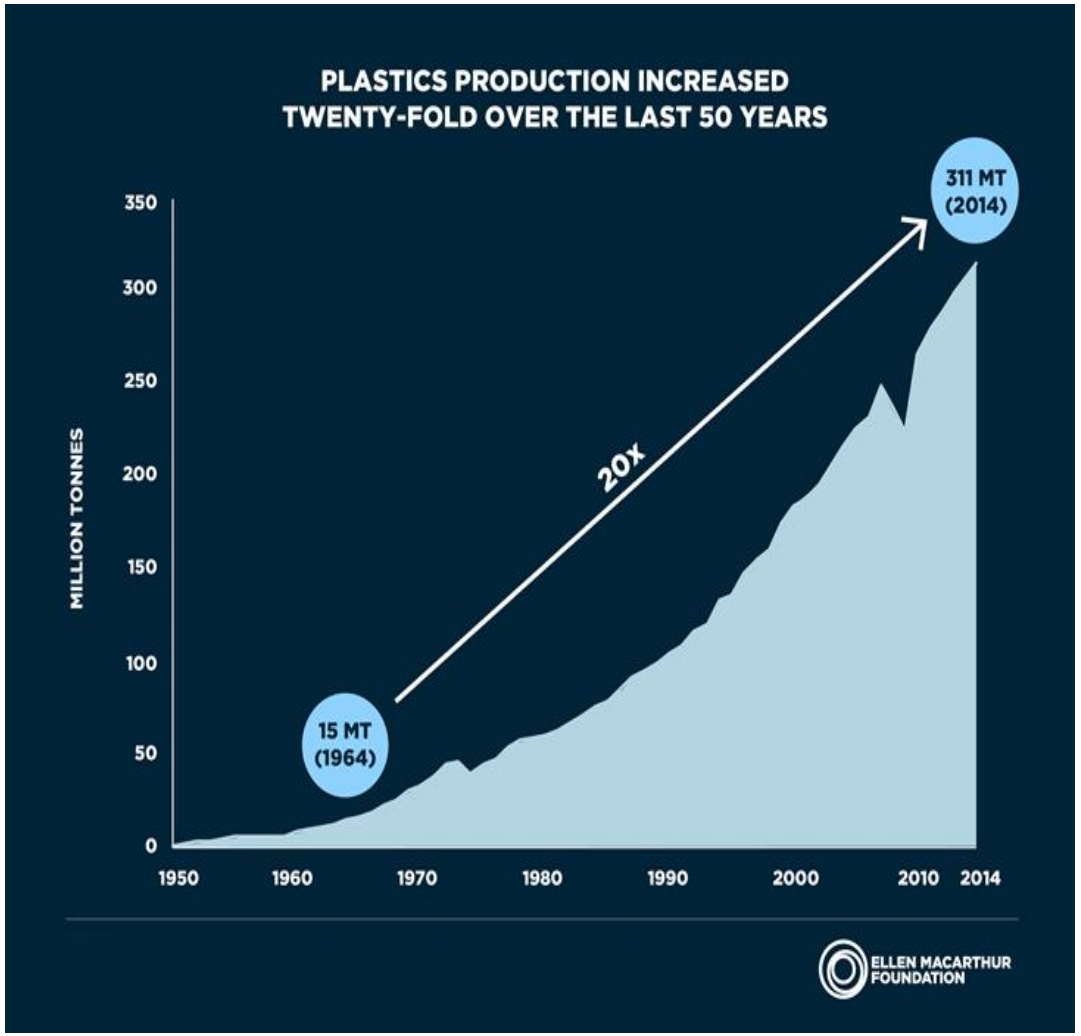


Motala, Sweden

- Packaging waste: 17,5 t/h
- 22 Sensor based sorting systems (NIR)
- Sorted products:
  - PE Film
  - PET Bottles
  - PET Trays
  - HDPE white/transparent
  - HDPE mixed color
  - PP
  - Mixed plastics
  - Metals (Fe/NFe)

PLASTIC PACKAGING MATERIAL FLOWS





FUTURE RECYCLING TARGETS

	Today situation	2025	2030
Overall packaging		65%	70%
Plastics	**22,5%**	**50%**	**55%**
Wood	15%	25%	30%
FE Metals	50%	70%	80%
Aluminium	30%	50%	60%
Glass	60%	70%	75%
Paper & Cardboard	60%	75%	85%
Household waste		**55%**	**60%**

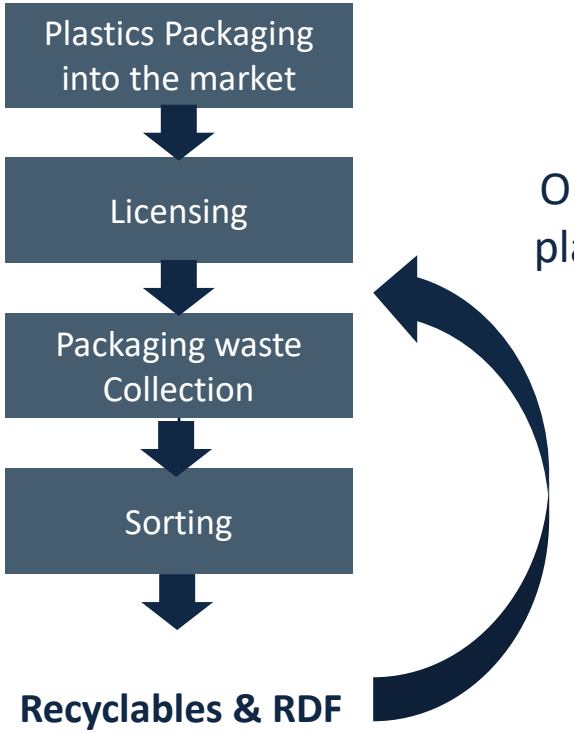
Other drivers are:

- High disposal costs
- Potential savings
- China effect
- Green thinking
- Available technology
- Customer demand
- Image saving

EU ist starting, ROW will follow!

SITUATION WITHIN PLASTIC IN **EU** AND CHANGES COMING

Official way of reporting today

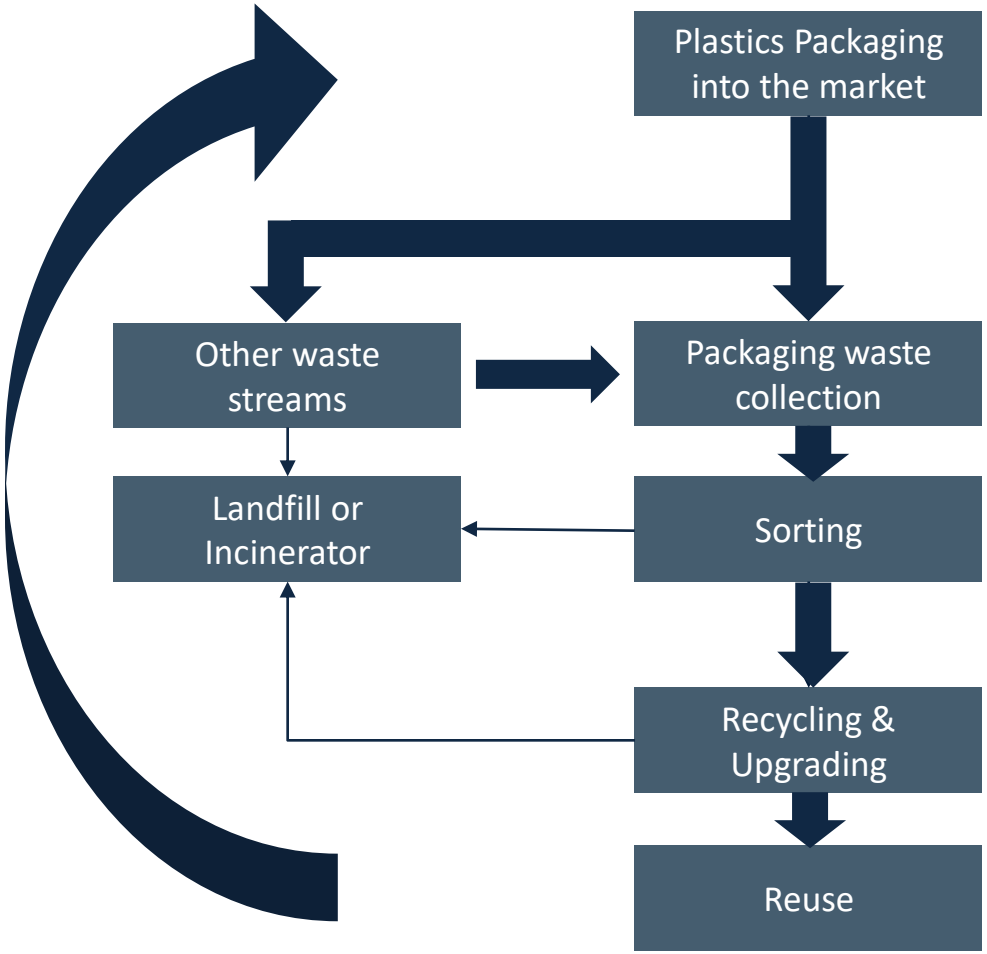


Output of sorting plant is compared to licensed amount

e.g. 50% is just 35% in reality

Real material flow and numbers

Only the true recycled material is accounted towards the total volume



DESTINY OF PLASTICS (MAINLY POLYOLEFINS) TODAY

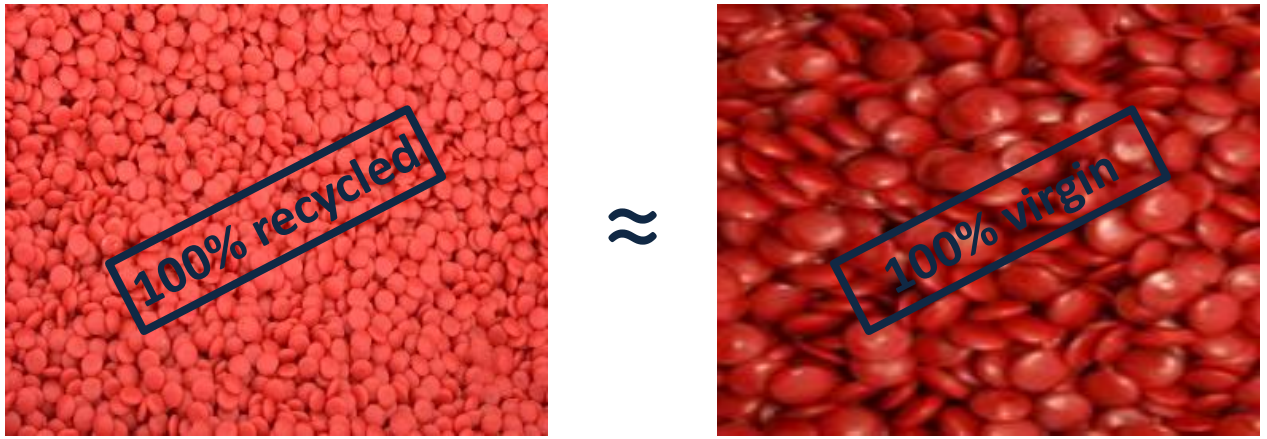
Recycling is not always recycling!

- Recycling of polyolefins often results in downcycling of the material, which means only products of lower quality standard can be made with the recycled material.
- **The recycling process makes the difference between high and low quality recycling.**

POST CONSUMER PLASTICS – HIGH QUALITY RECYCLING

Since 2014 large scale post consumer plastic recycling project/trials in collaboration with several brand owners!

- Upgrade post-consumer PO´s to a level that makes it possible to replace virgin material with up to 100% recycled material.



HDPE/PP MATERIAL OUT OF DIFFERENT SOURCES – FEEDSTOCK

Municipal Solid Waste

Packaging waste

Construction & Demolition

HIGH QUALITY **PP** RECYCLING FROM MSW

- Material and color sorting.

HIGH QUALITY **PP** RECYCLING FROM MSW






- Grinding
- Washing
- Flake sorting by material and color
- Extrusion
- Decontamination






HIGH QUALITY **PP** RECYCLING FROM MSW

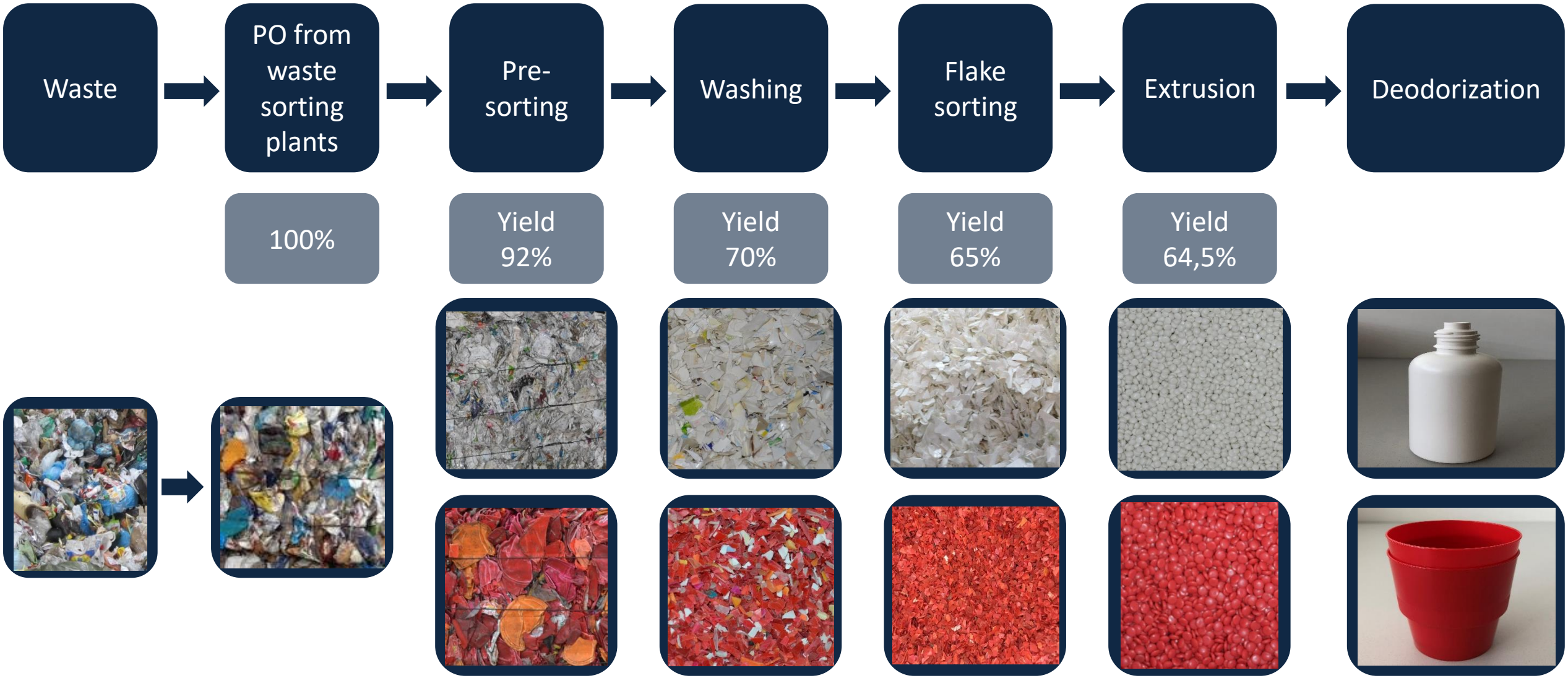
Ref racoPP (+UV + slip) | Tomra C-VAC 25% | Tomra C-VAC 50% | Tomra C-VAC 100%

Ref racoPP | Torma PCU 100% | Tomra C-VAC 100% | Tomra weiß 100%

PRODUCT QUALITY, CHEMICAL MEASUREMENTS IN FINAL PRODUCTS

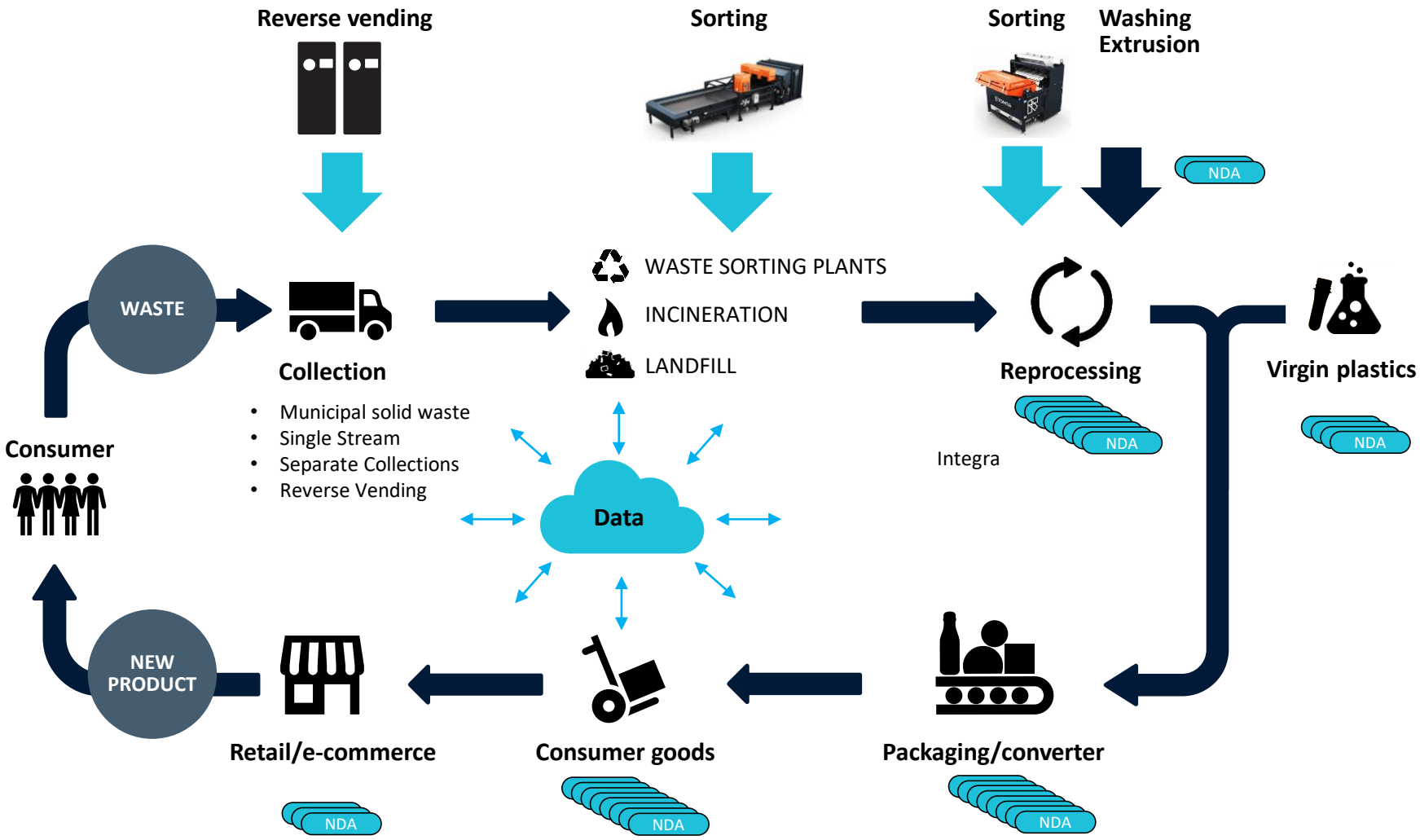
Organic acids	All results << limits
Parabene	
Further preservatives	
Azo (22 amine + xylidine)	
Biocides	
Formaldehyde	
Bisphenol-A migration	
Chloroparaffins	
Dimethylfumarate	
Brom, Biphenyls and Biphenyl ether	
Flame retardants, brominated phenols	
Flame retardants, organophosphates	
Flame retardents, TEPA	
Metals	
Heavy metals	
Organotin compounds	
Plasticizer	
Polycyclic aromatic hydrocarbons	
Vhromium	
Triclosane	

DESCRIPTION OF TRIALS – DEVELOPMENT WORK



INDUSTRIALIZING THE PROCESS FOR RECYCLED PLASTIC

- **Create a demand** for the plastic through the process.
- Output to be of **high quality** in order to replace virgin material up to 100%.
- Extract **plastics from all waste streams** (incl. landfill and incineration) to satisfy demand.
- **Feasibility proven**, working with multiple partners on commercialization.



WHAT DOES IT MEAN **'IT IS RECYCLABLE'**

It is collected - introduction of waste collection systems globally.

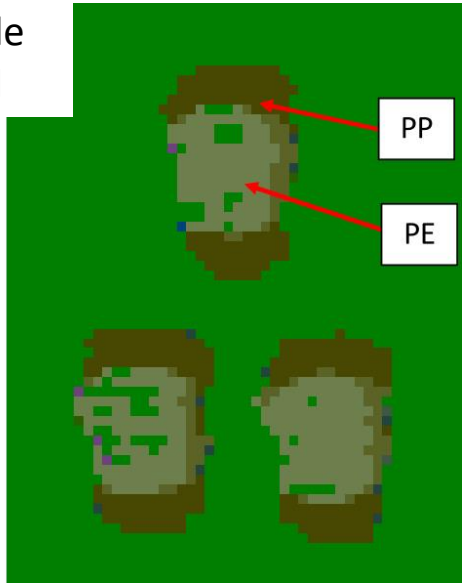
It is detectable/sortable - make sure that the optical sorters can identify main used material. Please use the commonly sorted and recycled materials e.g. PE, PP, PET.

It is recycled/processed - make sure that labels and glues can be washed off. Do not use material which will obstruct the reprocessing e.g. silicone.

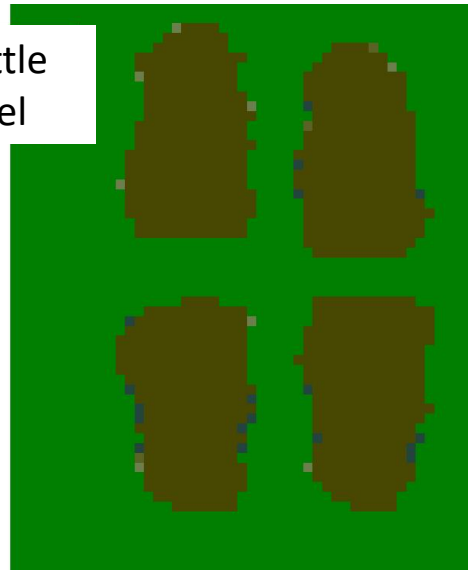
Exists an application - the recyclate can be used for various applications.

DESIGN FOR RECYCLING – ECODESIGN WORKSHOP

PP bottle
PE label



PP bottle
PP label

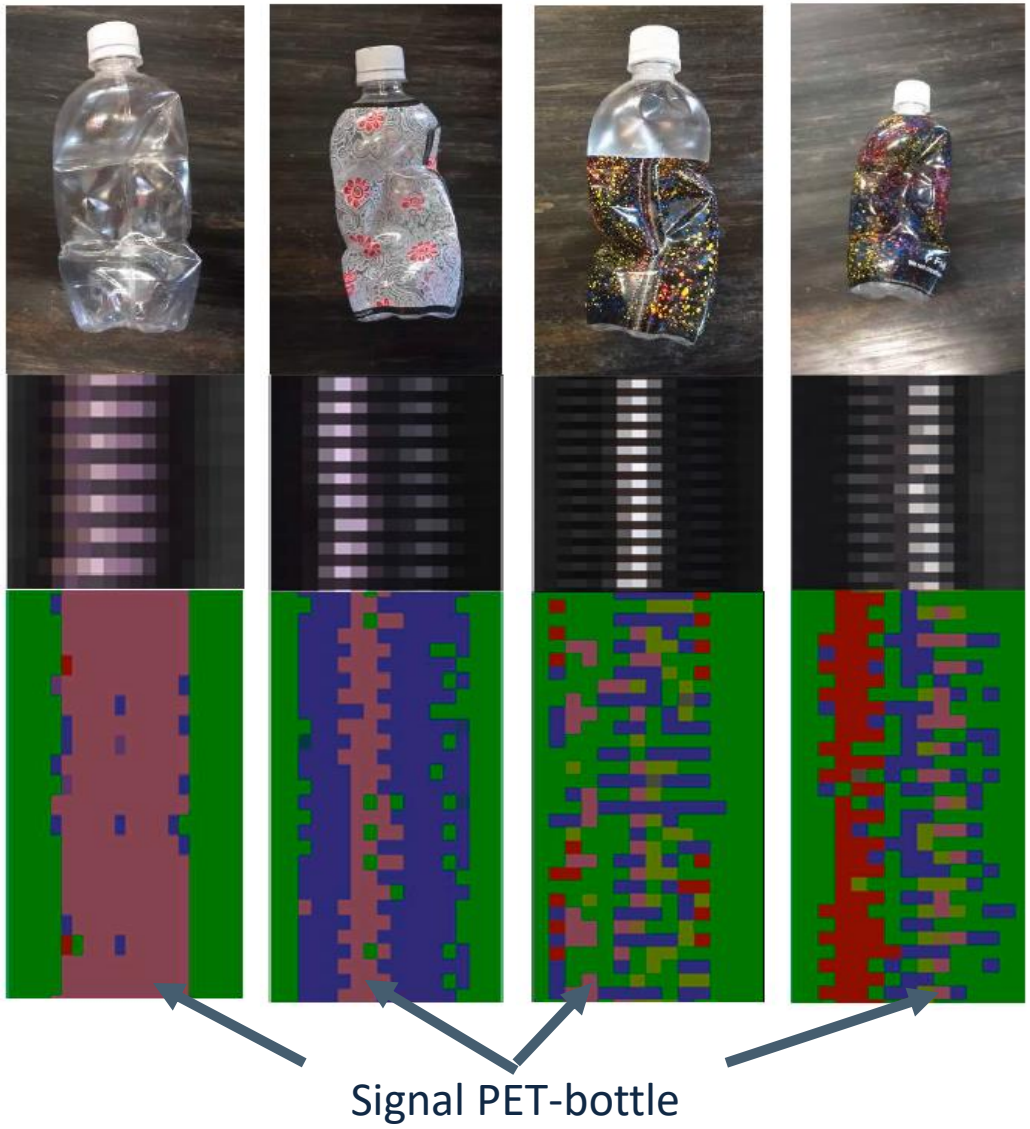


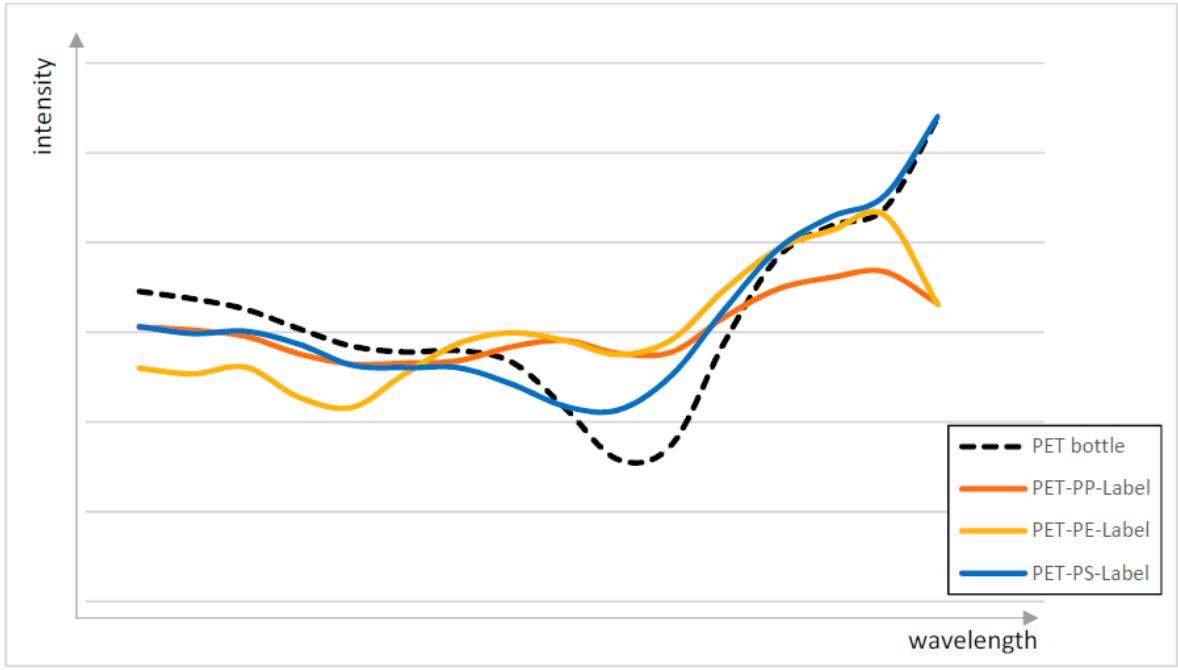
Nye etiketter redder 260 tonn plast

Idun Tomatketchup og Idun Sennep får i vinter nye etiketter som øker resirkuleringsgraden av flaskene til over 70 prosent.

15.02.2019

DESIGN FOR RECYCLING – FULL BODY SLEEVE PET-BOTTLE

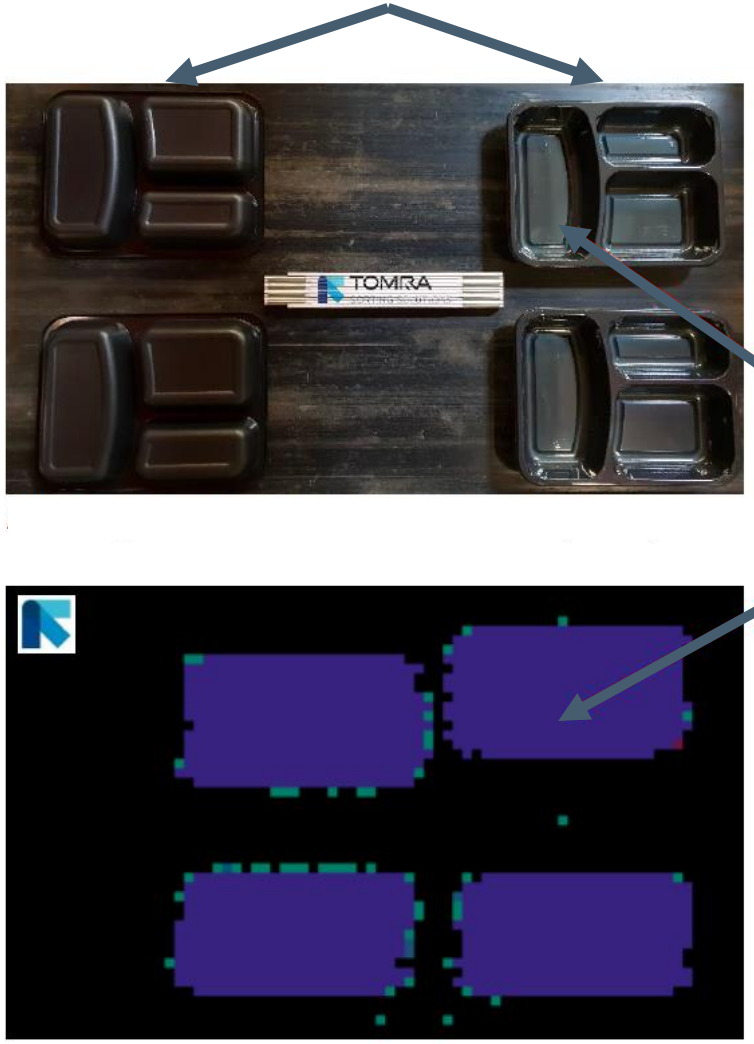




Overview of several PET-label spectra

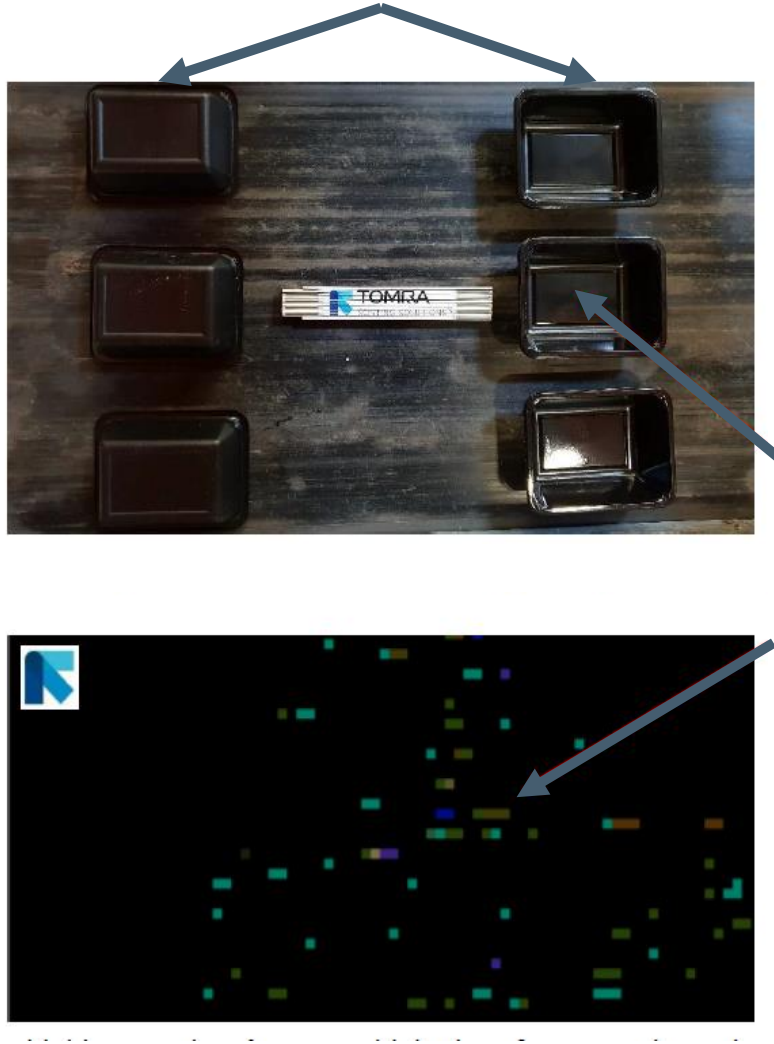
DESIGN FOR RECYCLING – BLACK PACKAGING

PET-tray without „carbon black“



The sample is fully recognized as PET

PET-tray with „carbon black“



The material gives no detectable information

SUMMARY

- Around the world, **PET bottles** are high-quality recycled (bottle-to-bottle).
- Most of **HDPE/PP/PET non-bottle** and **LDPE** is primarily recycled into lower quality products, if sorted/recycled at all.
- With good sorting and washing equipment, most plastics could be **high-quality recycled**, independent from the post consumer waste source.
- The sorting technology will **continue to evolve**.

Two main issues:

- Just a **small part of plastic** is sorted out of waste.
- Some packaging materials are designed in a way that **sorting or recycling is not possible/difficult**, but currently increased focus of packaging producers on design for recycling

"Museums of the world save the past, recyclers - the future“

www.tomra.com/recycling