

# TOMRA SORTING

## WHAT'S NEXT- TOWARDS A CIRCULAR ECONOMY

# CONTENT

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- Who is TOMRA?
- The Circular Economy in practice
- Digital – TOMRA Insight
- Sorting technologies- what's next?

4000+

EMPLOYEES  
GLOBALLY

Publicly listed on Oslo Stock Exchange (OSEBX: TOM)



8.6

BILLION NOK  
REVENUES IN 2018



FOOD



RECYCLING



MINING



REVERSE VENDING

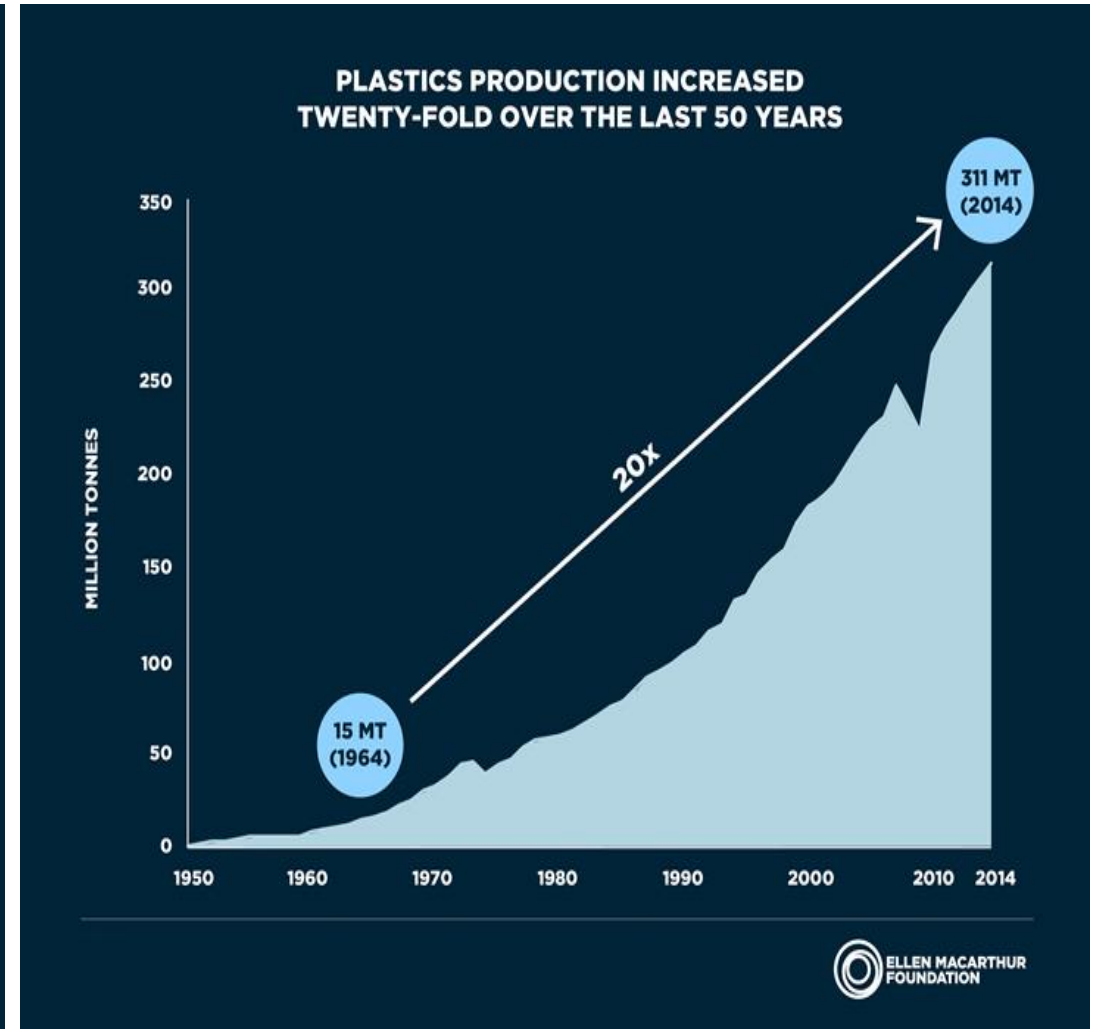
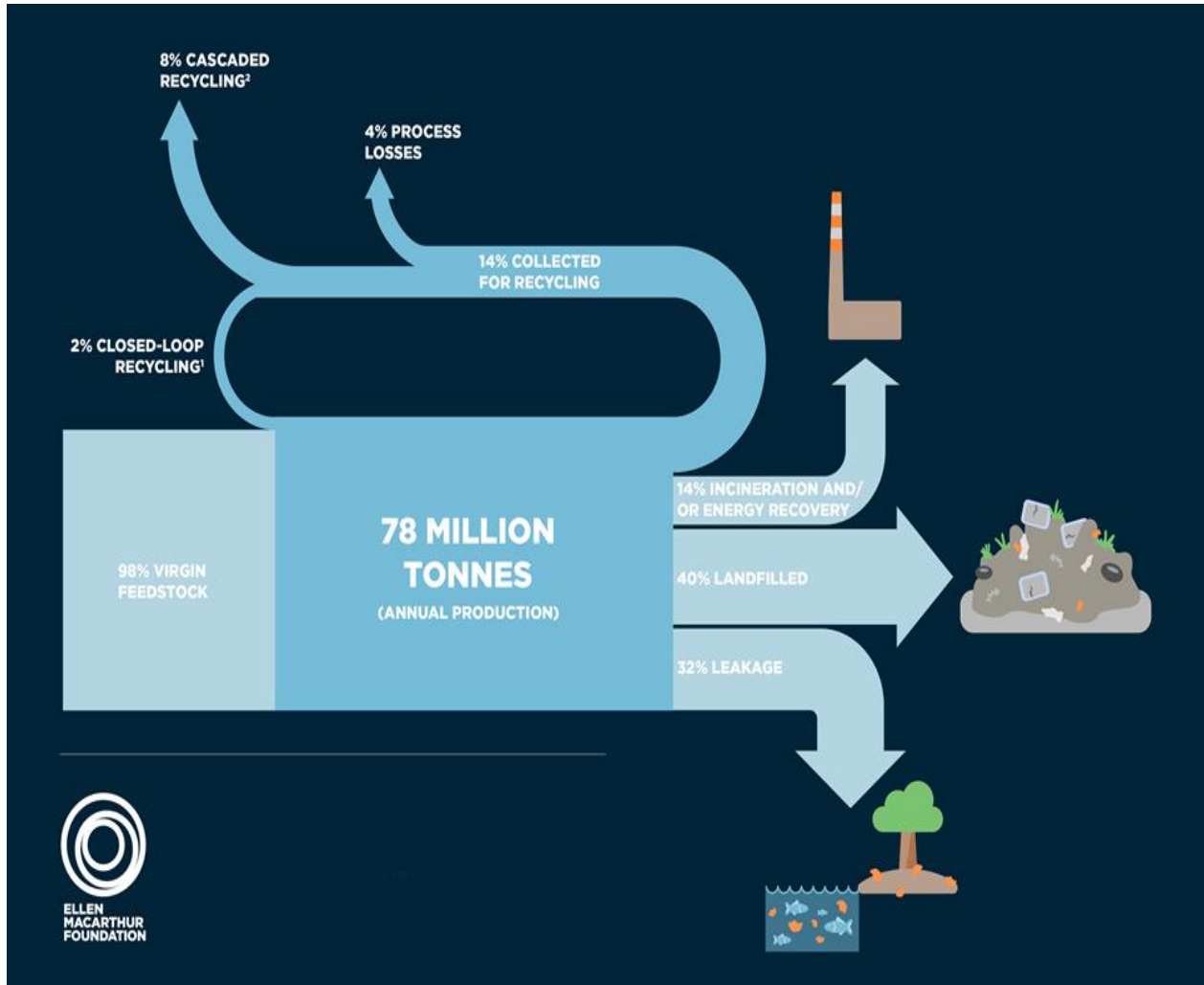


MATERIAL RECOVERY

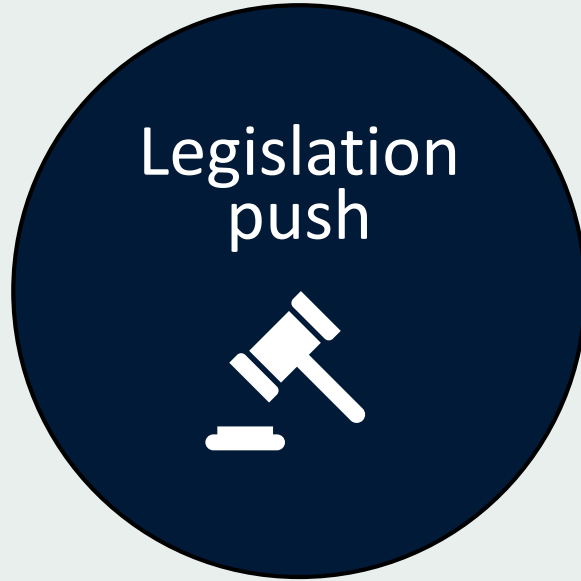


Circular Economy

# PLASTIC PACKAGING MATERIAL FLOWS

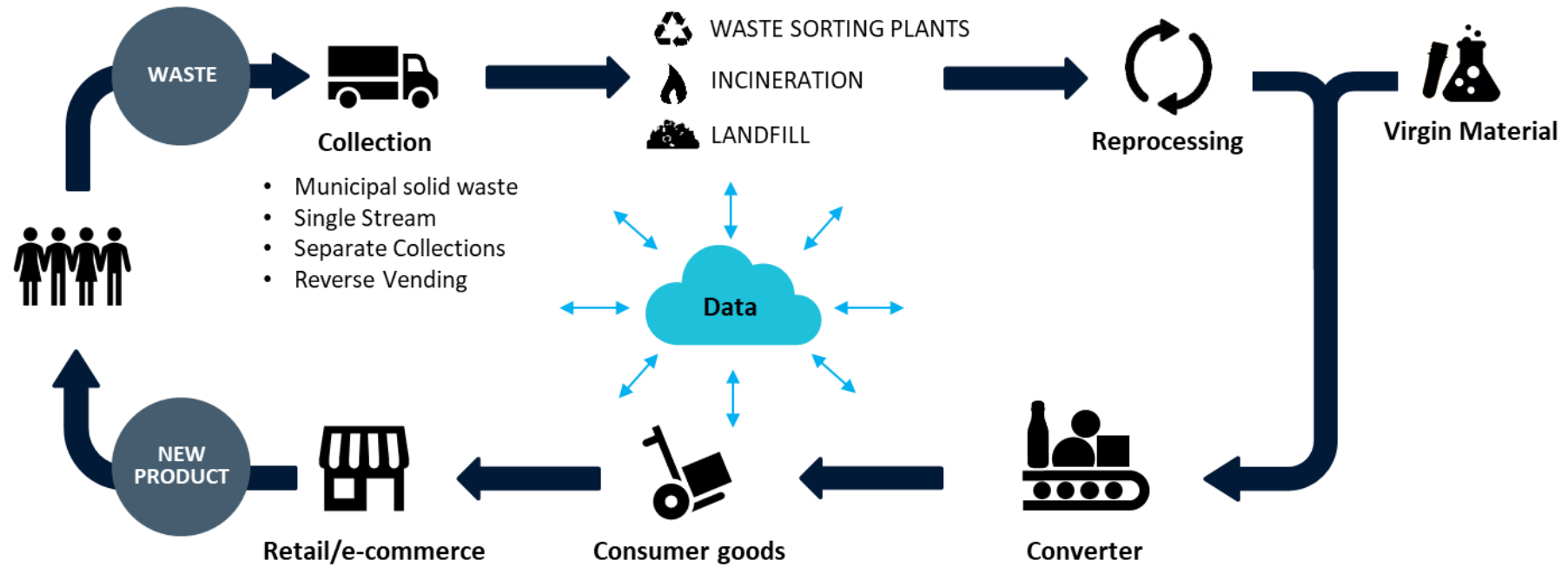


# Why now?



# INDUSTRIALIZING THE PROCESS FOR RECYCLED PLASTIC

- **Create a demand** for the plastic
- 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'

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**It is collected** - introduction of waste collection systems globally.



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



**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.



**It has an application** - the recyclate can be used for various applications.

# DESIGN FOR RECYCLING / ECODESIGN WORKSHOPS



**ROAF**

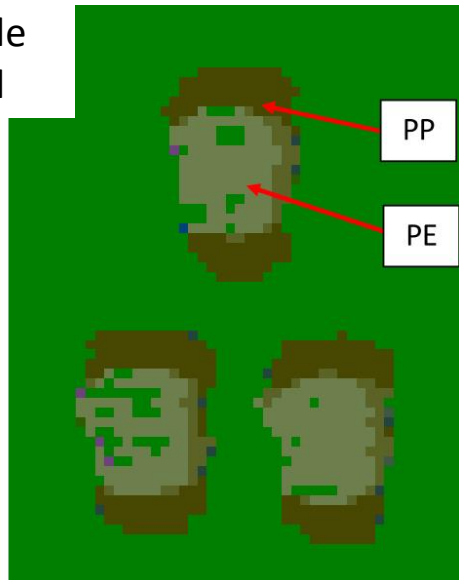




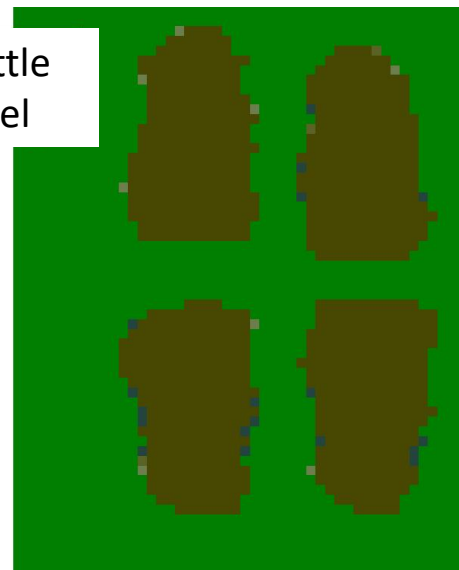
# DESIGN FOR RECYCLING – ECODESIGN WORKSHOP



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



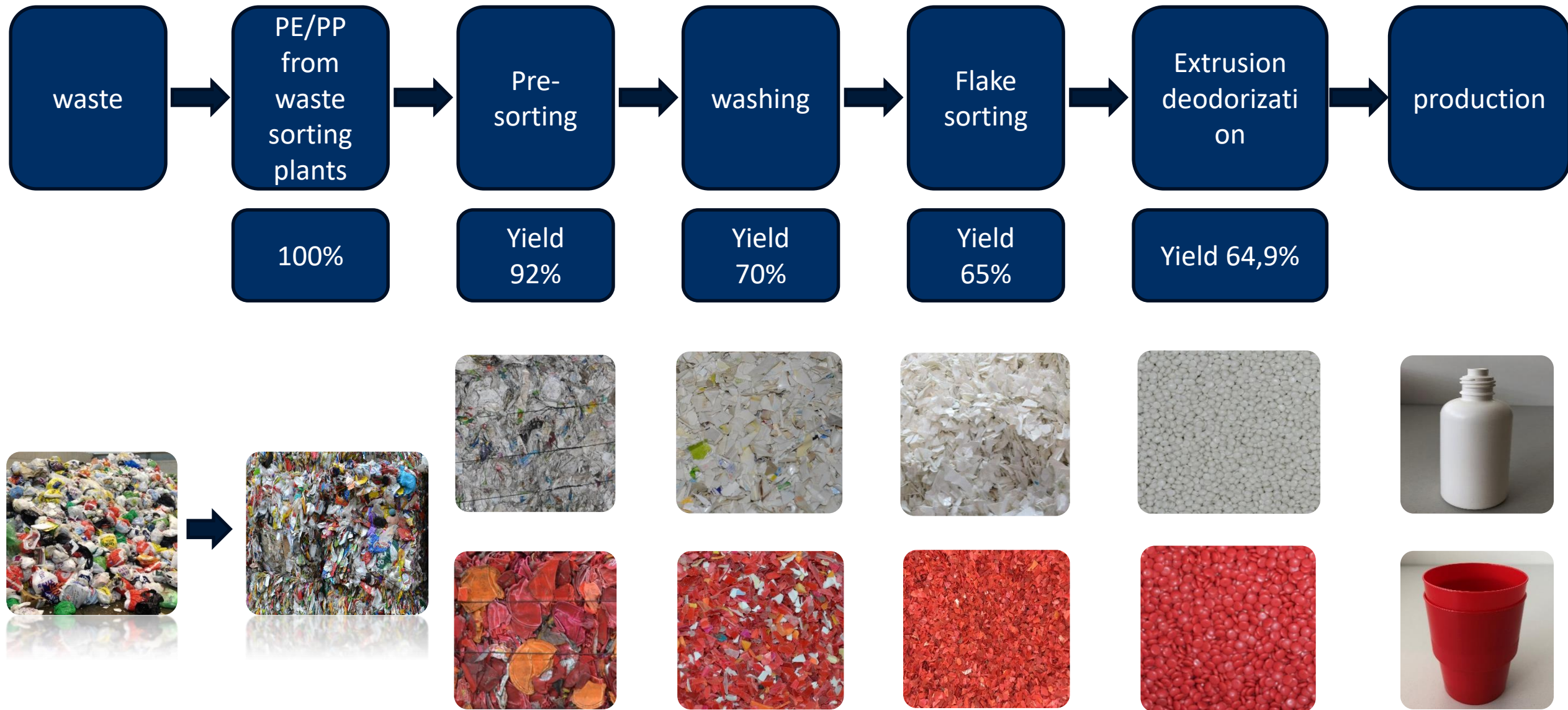
# COLLECTION/SORTING - IMPORTANCE OF MSW SORTING PLANTS



## IVAR, Stavanger, NORWAY

- Municipal solid waste (MSW): 40 t/h + separately collected paper: 15 t/h
  - 22 Sensor based sorting systems (NIR)
  - Sorted products
    - PE film
    - PET bottles
    - PP
    - HDPE
    - PET trays or PS
    - Mixed plastics
    - Mixed paper + beverage carton
    - Deinking paper negative
    - Beverage carton
  - Hot washing + extrusion line for film and PE/PP hard plastics
- ~17-18 kg/ (cap \* a)**
- Av. Norway collection 6-7 kg/(cap \*a)**

# POST CONSUMER PLASTICS – HIGH QUALITY RECYCLING





Reduce  
Downtime



Maximize  
Throughput

# TOMRA DIGITAL-ACCESS TO INFORMATION UNLOCKS NEW OPPORTUNITIES



Reduce  
Operational Cost



Sort to  
Target Quality

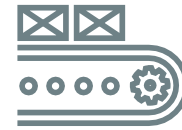
# GET THE MOST OUT OF YOUR PLANT



## Reduce Downtime

Today: Identification of production gaps  
Analysis of downtime

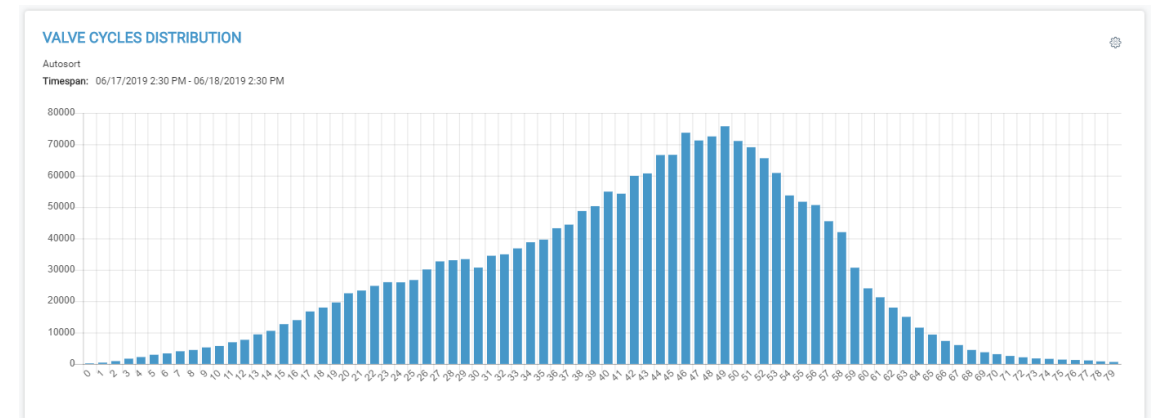
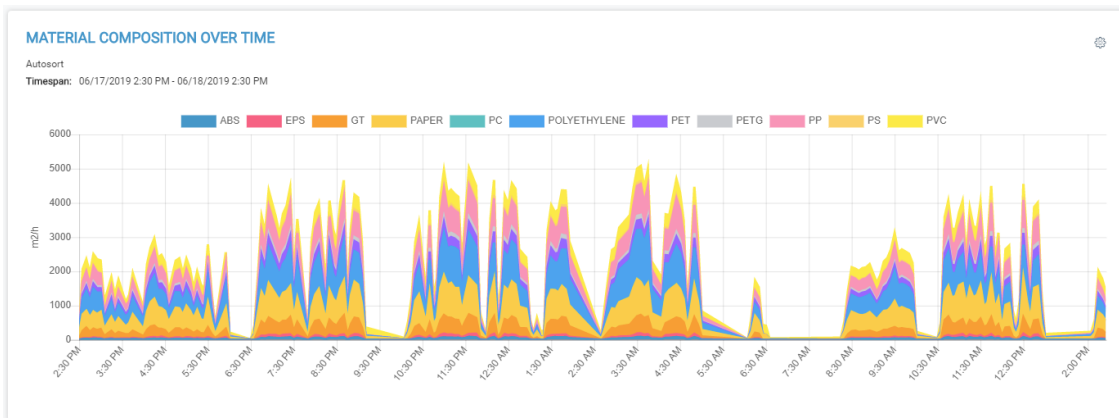
Future: Prediction of valve failure



## Maximize Throughput

Today: Evaluation of material distribution  
Analysis of throughput variations

Future: Automated alarms and recommendations



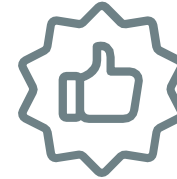
# INCREASE PROFITABILITY OF YOUR INVESTMENT



## Reduce Operational Cost

Today: Simplified re-ordering of spare-parts  
Access to documentation

Future: Further integration into business processes



## Sort to Target Quality

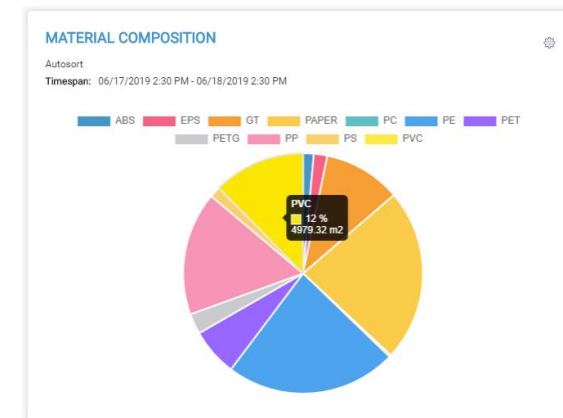
Today: Data transparency in the back office  
Fact-based decision making

Future: Sorting optimization across whole process

**RE-ORDER SPARE PARTS**  
Step 1: select products

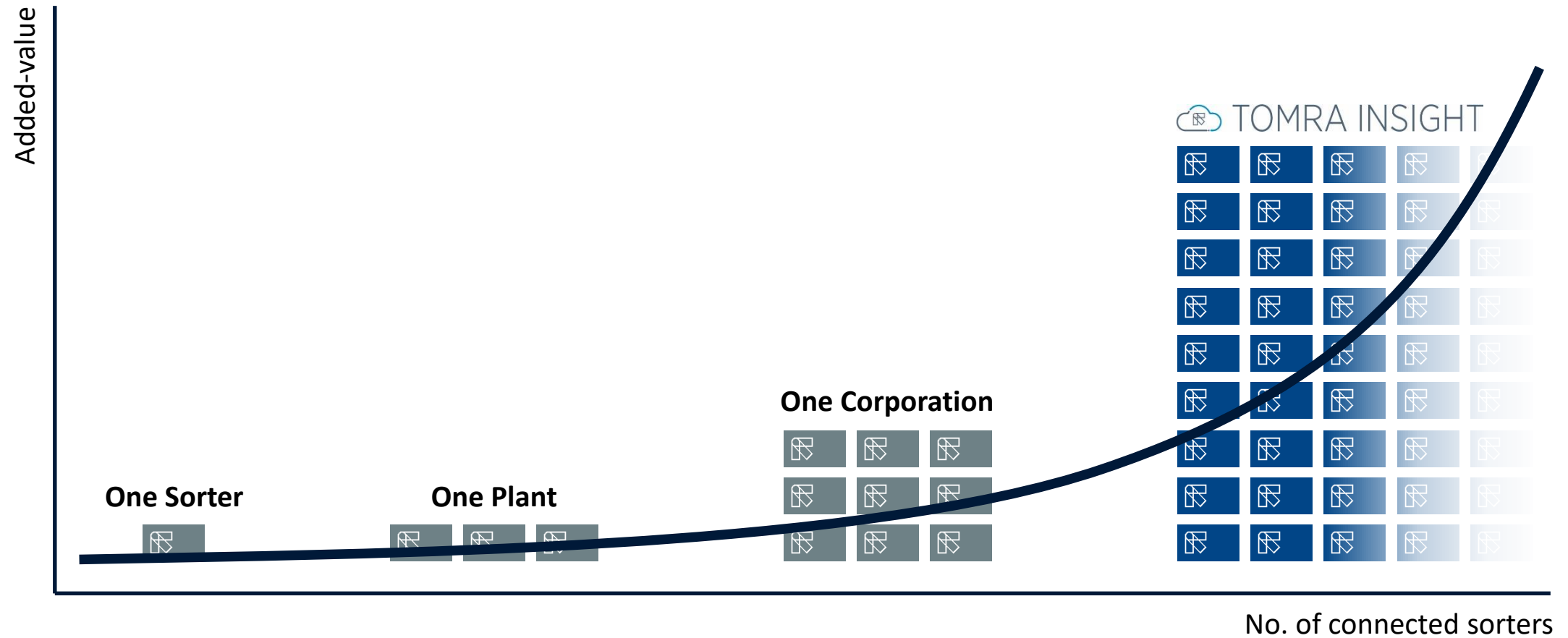
Part Number	Part Name	Order Date	Order qty
<input checked="" type="checkbox"/> 1206-004323	Lamp Socket Assy- ASA, TYPE 2	8/9/2019	10
<input type="checkbox"/> 5000-0071402-00	Cover VB ASA 0600-25	3/12/2019	1
<input type="checkbox"/> 5000-0000783-01	Kondensatormotor 1.5uF MKA-1.5-450 rRUusl	10/2/2018	5
<input type="checkbox"/> 5000-A550237-00	Lampe, trigger NIR Glühbirne mit Kabel	10/2/2018	5
<input type="checkbox"/> 1152-011283	Kondensattank, Metall mit Ablassautomatik	6/29/2018	2

Cancel NEXT



# THE POWER OF DATA

Maximize your foundation for data-driven and fact-based decision making by increasing the sample size

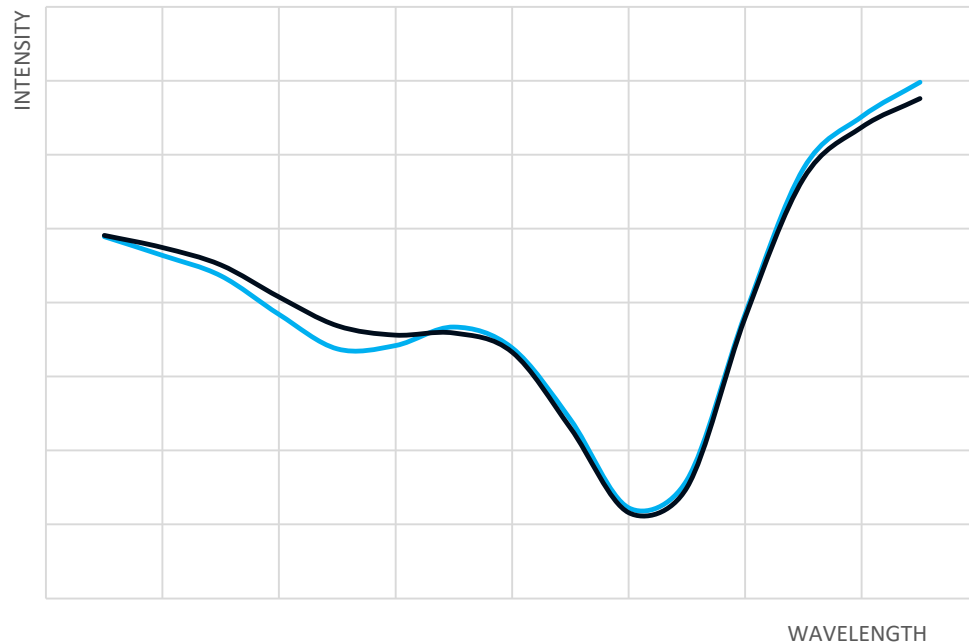


# WHAT'S NEXT- NEW TECHNOLOGIES / MOTIVATION



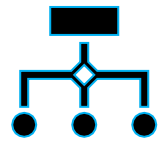
Using a **new technology** to achieve the high product and customer requirements, which can not be solved using conventional technology.

### SPECTRA OF NIR



PE-HD vs PE-HD Silicon Cartridges





## Artificial intelligence

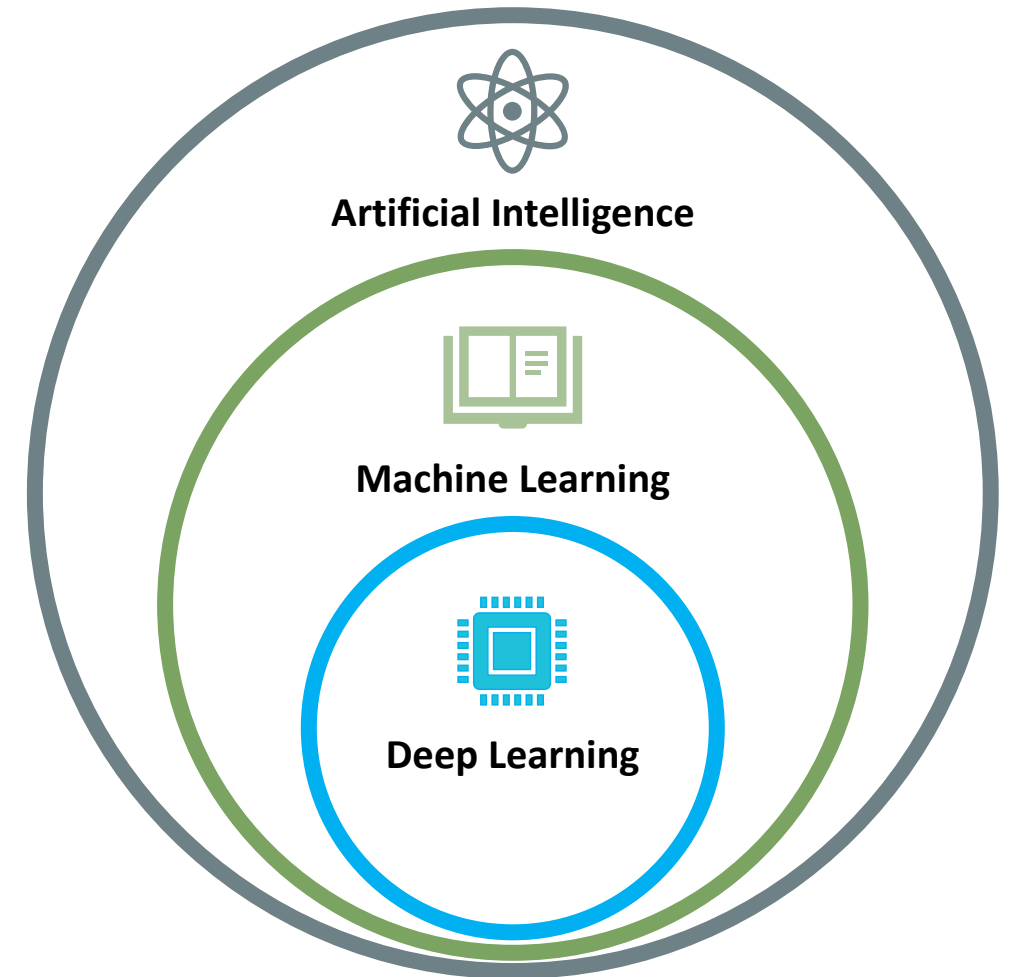
- is intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans
- is any **technique** that enables computers to **mimic human intelligence**
- Artificial intelligence is a part of computer science

## Machine learning

- Is the scientific study of algorithm and statistical models. Computer systems use to perform a specific task **without** using **explicit instructions**.
- relying on patterns and inference instead Machine learning is a part of artificial intelligence

## Deep Learning

- Use **artificial neural networks** which are inspired by information processing and distributed communication nodes in biological systems.
- Deep Learning is a part of machine Learning



*Training a network can be compared to learning a toddler.*

*By showing an object several times and explaining what it is, the toddler trains himself.*

*After a while and several trainings it is possible to assign the objects correctly.*

*This principle is also pursued by Deep learning*

# DEEP LEARNING "GAIN"



## Detection without Deep Learning

- Feature engineering working principle:
  - object characteristics must be defined
    - Shape / Ratio / Filling...



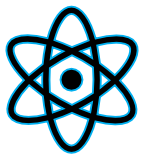
Impurities  
PE-HD SC

PE-HD

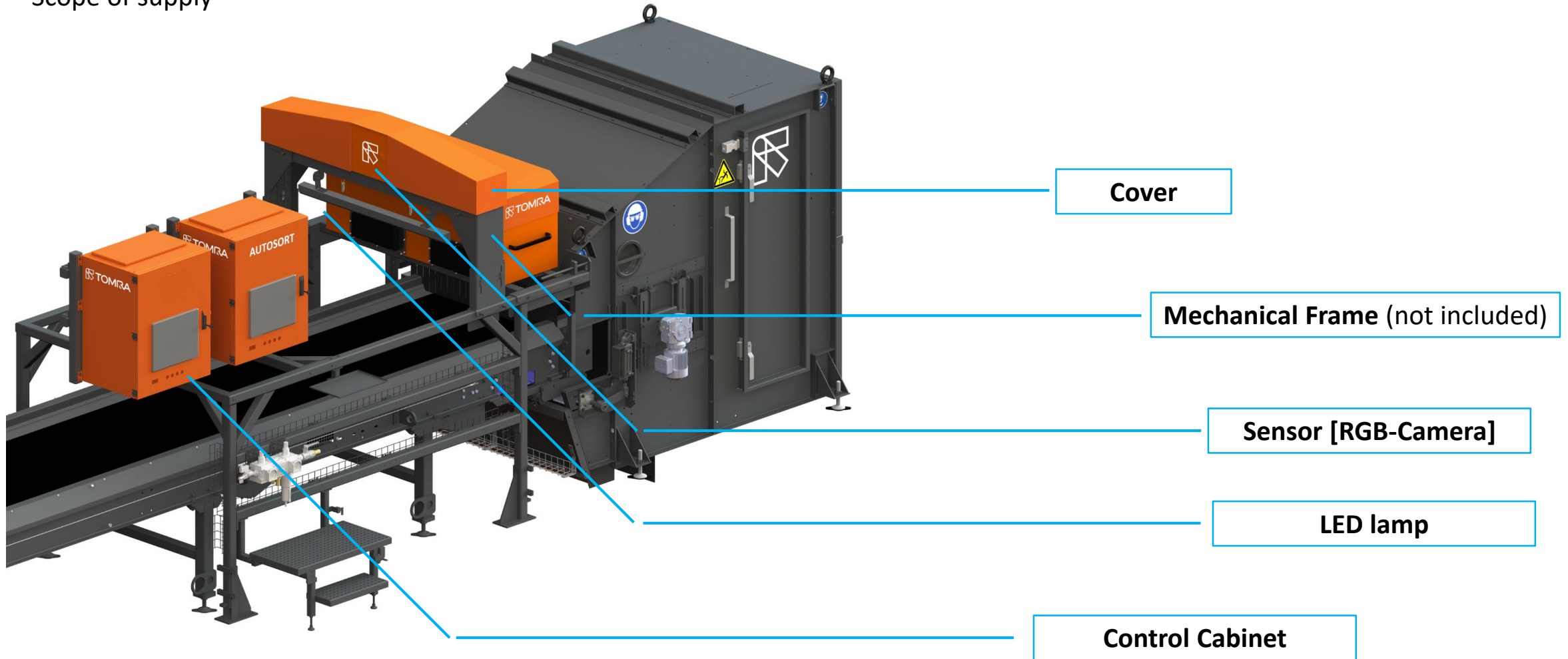


- simple image processing like Object Recognition [feature engineering] solve the problem only seemingly.
- as soon as objects touch, overlap or are deformed, this technique no longer works.
- Technology only works in the parameter specified by humans
- GAIN allows also detection of overlapping, touching, deformed and destroyed objects





## Scope of supply



# DEEP LEARNING-CASE STUDY



Input material	
Input material	PE-HD
Grainsize	> 50 mm
Bulk density	50 - 60 kg/m <sup>3</sup>

	Input	Recovery Step 1	Recovery step 2
PE-HD silicon cartridge number of pieces	60	58	2



PE-HD silicon cartridge 60 numb. of pieces



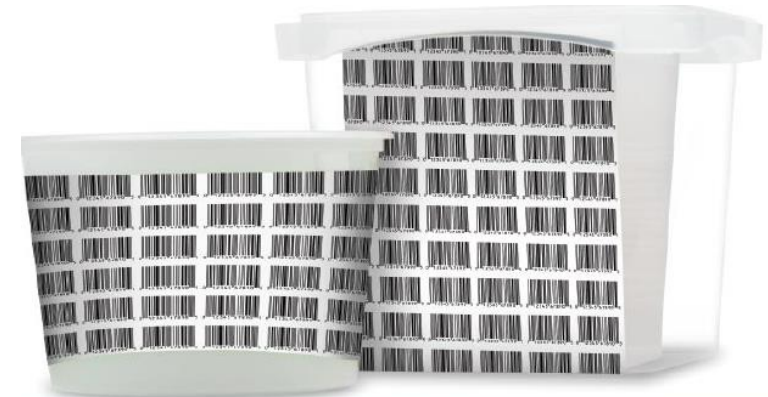
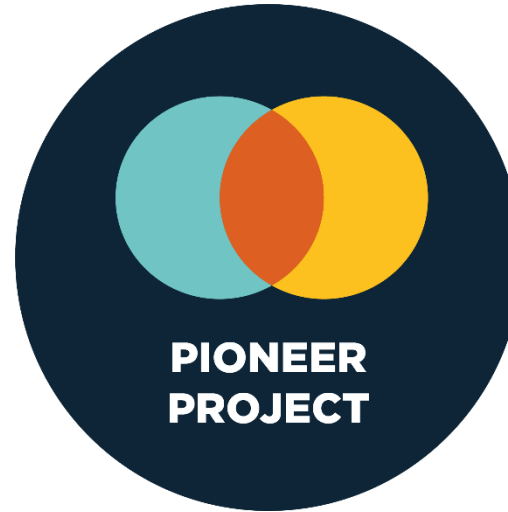
Step 1 Recovery of PE-HD silicon Cartridges 96.7%



Step 2 Recovery of PE-HD silicon Cartridges 100%

# WHAT'S NEXT- OVERCOMING TODAY'S LIMITS – DIGITAL WATERMARKS

- **Improve detection and sorting** of materials, also of “difficult to sort / recycle” fractions
- Enable **food and non-food** recycling applications, among others
- **Proof-of concept successful** within Holy Grail project (open house May/ October in Germany)
- **Further prototype development and industrial trials** within Holy Grail 2.0



HOW IT ALL BEGAN....







...good times for Circular Economy in Norway





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

[www.tomra.com/recycling](http://www.tomra.com/recycling)