

MAKING ALUMINUM SCRAP RECYCLING WORTH WHILE

AMAP COLLOQUIUM, APRIL 12TH 2018

CONTENT OF TODAY'S PRESENTATION

- Introduction of TOMRA Sorting, the Recycling division and TOMRA Systems
- Introduction to Sensor Based Sorting and the available sensors
- Overview of applications and installations of sensor based sorting in the Aluminum Recycling Industry
- Application Examples from different Industries
- Sorting of Production Scrap by alloy group
- Summary



TOMRA SORTING AND TOMRA SYSTEMS

IDEAS
INTO 
ACTION

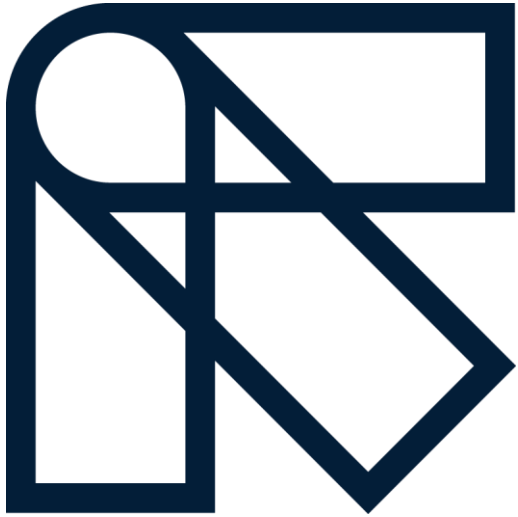
A wireframe globe is positioned in the center of the slide, partially overlapping the white text area. The globe is composed of a grid of lines forming a sphere, and it is set against a background of a bright sun or light source in the upper right, creating a warm, golden glow. The globe's lines are dark, and it appears to be a stylized representation of a globe or a sensor array.

110*
YEARS COMBINED
INDUSTRY &
SORTING
EXPERIENCE

PIONEER IN SENSOR-BASED SORTING

Offering cutting-edge technology for industries where automated sorting and processing are key for value creation.

10,500
INSTALLED UNITS



FOOD

Potatoes, vegetables, nuts, dried fruit, seeds & grains, fruit, fresh cut, seafood, meat, gummies, tobacco

Steam peelers for potatoes, vegetables and fruits, process analytics for fat & moisture analysis

MINING

Industrial minerals, gems, precious metals, ferrous metals, non-ferrous metals, fuels

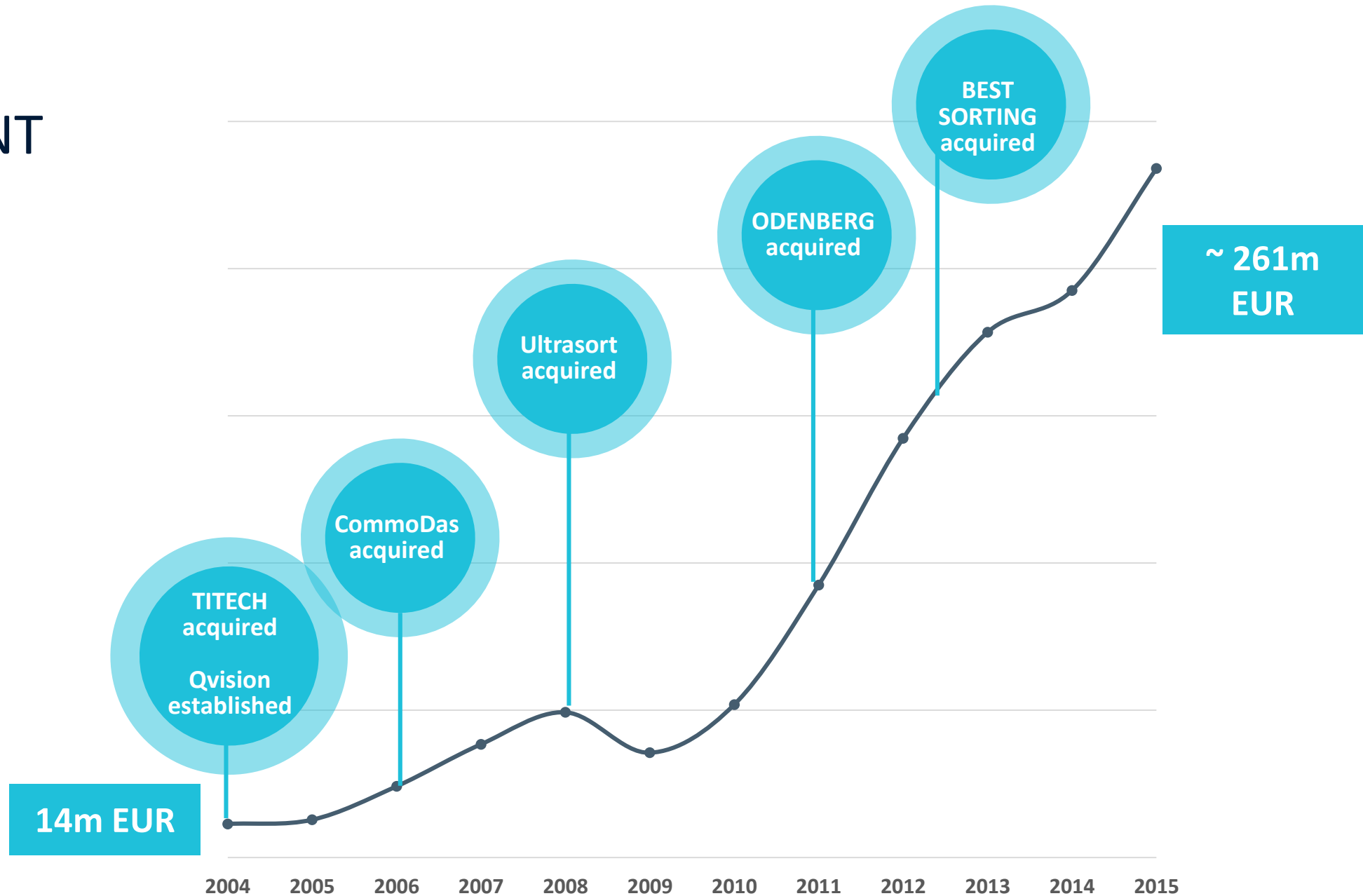
RECYCLING

Municipal solid waste, packaging, commercial & industrial waste, automobile shredder, electronic scrap

REVENUE DEVELOPMENT AND KEY MILESTONES

MEUR

- Total revenue growth (organic plus inorganic) **CAGR of ~32% per year** from 2004-2015
- **Average annual organic growth** for the same period was **~21%**
- Technology base and segment/application knowledge expanded both through acquisitions and in-house ventures





INCREASE REVENUES

- Enhance purity
- Increase recovery rate
- Consistent quality of output streams
- New and innovative business fields



REDUCE COSTS

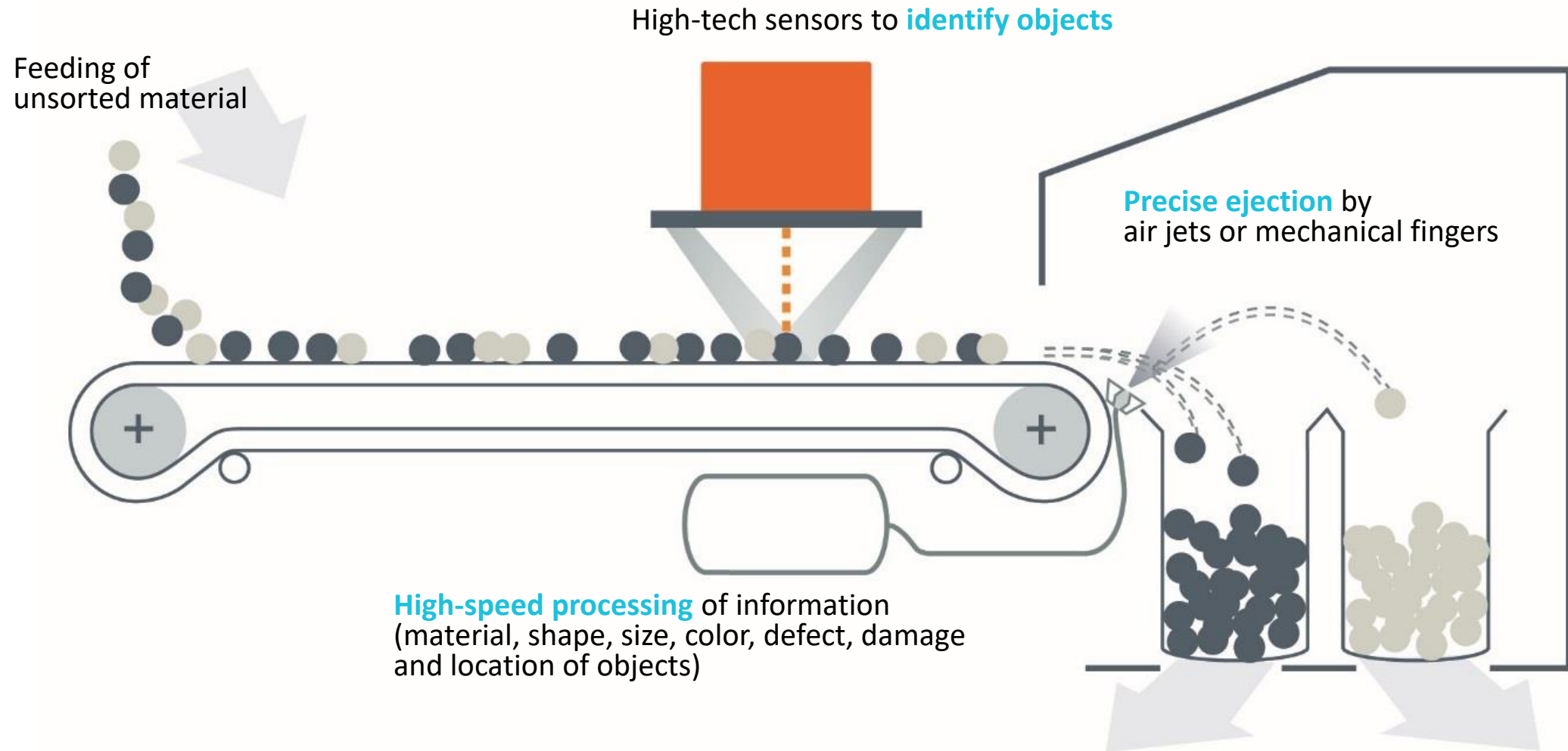
- Reduce labor requirements
- Lower operational and service costs
- Low space requirements
- Easily adaptable



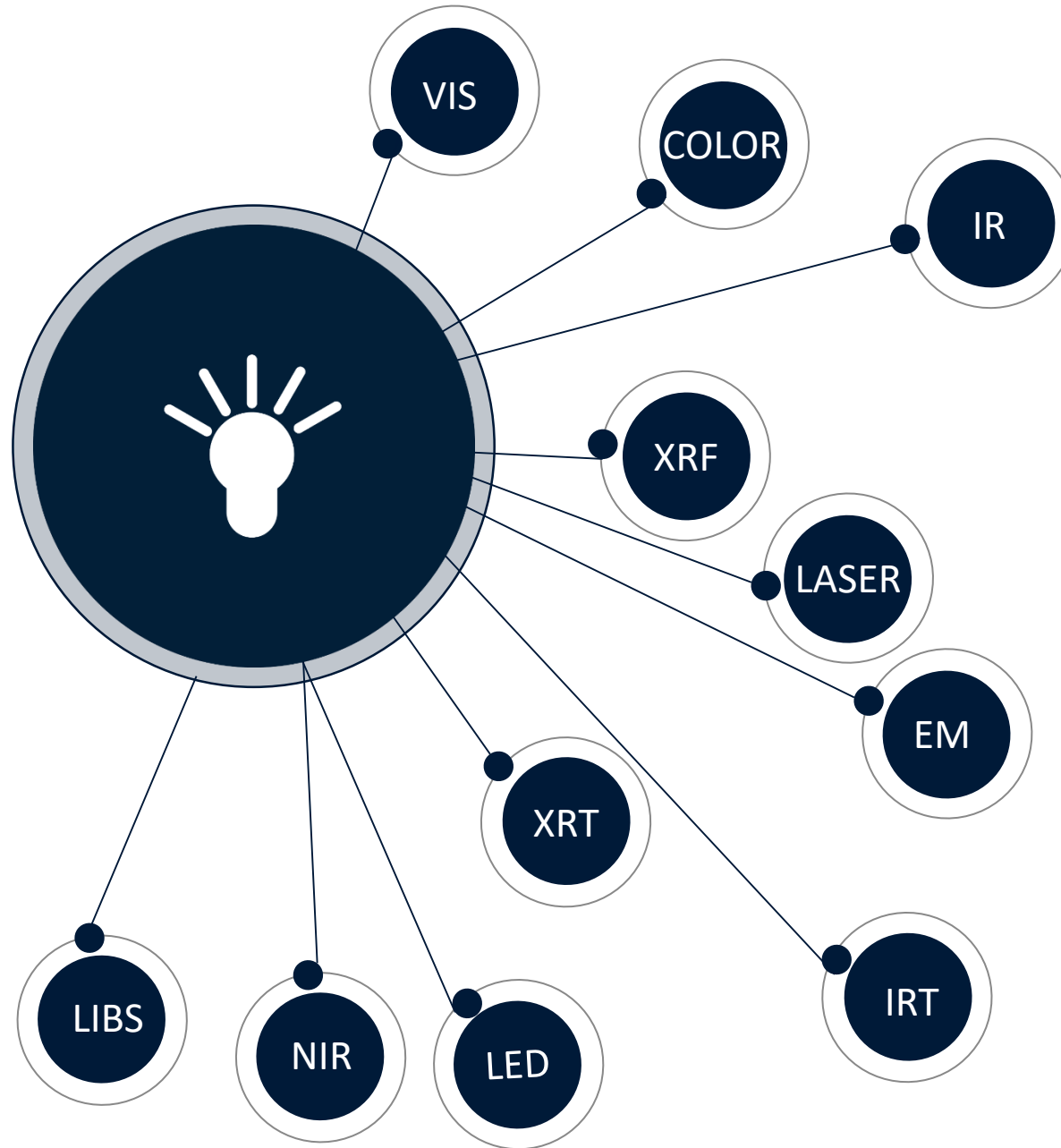
OTHER BENEFITS

- Significantly fewer landfills
- More efficient use of primary resources
- Less environmental pollution

PRODUCT-SPECIFIC EQUIPMENT DESIGN OFTEN INCLUDING MULTIPLE TECHNOLOGIES TO MAXIMIZE SORTING EFFICIENCY



BROAD SENSOR PORTFOLIO



20%

of all employees work
in **in-house R&D**

8%

of revenue
reinvested
in R&D

80

patents owned

KEY FACTS AND FIGURES R&D

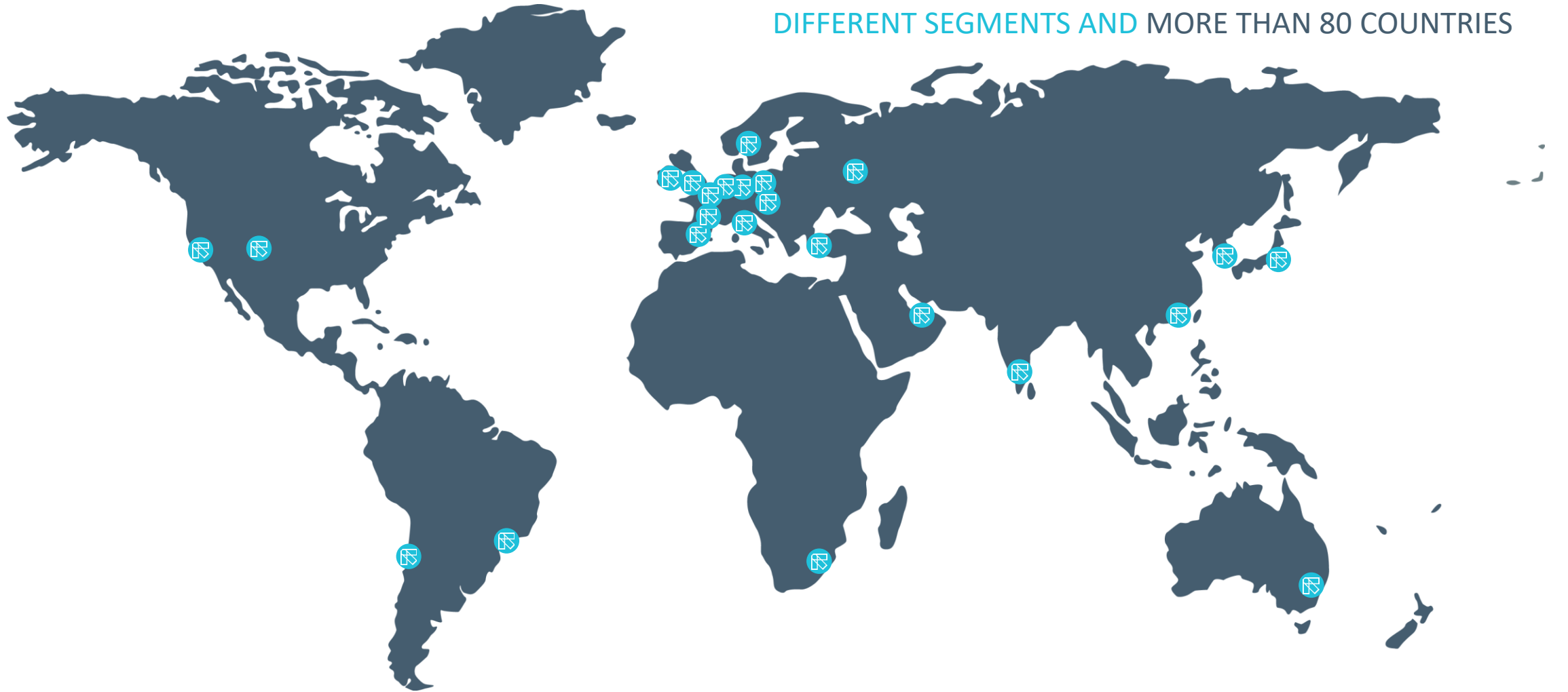
Partnership with leading
R&D institutions (SINTEF,
CTR, Fraunhofer ILT;
Universities like RWTH and
Brussels)

Development of
own sensors

**Own software and
data processing tools**

GLOBAL PRESENCE

AN EXTENSIVE AGENT & DISTRIBUTOR NETWORK COVERING DIFFERENT SEGMENTS AND MORE THAN 80 COUNTRIES



 TOMRA Sorting subsidiary

HIGH STANDARD PRODUCTION & WORKSHOPS

Quality, Environmental and Health & Safety management systems according to ISO 9001, ISO 14001 and OHSAS 18001

- BRATISLAVA, SLOVAKIA
- DENVER, US
- EINDHOVEN, THE NETHERLANDS
- KOBLENZ, GERMANY
- LEUVEN, BELGIUM

1300

AVERAGE NUMBER OF PRODUCED SYSTEMS PER YEAR



OUR TEST CENTERS: SORTING EXCELLENCE

Test your own
product or material in
our test centers
worldwide.



FOOD TEST CENTER
in Leuven, Belgium

 **16**
TEST
CENTERS

The complete sensor
portfolio can be
tested.

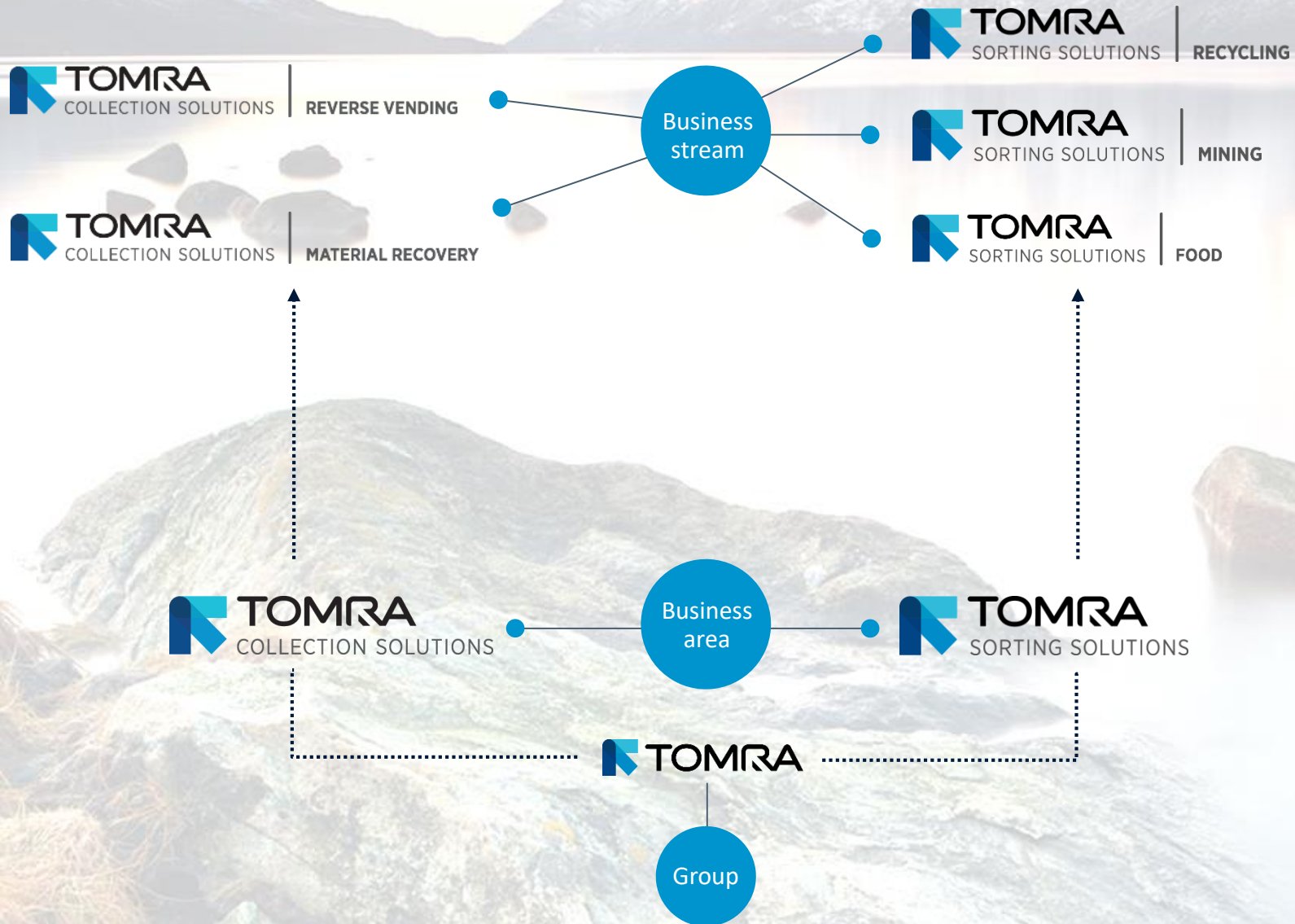


RECYCLING TEST CENTER
in Koblenz, Germany

Experienced
application engineers
develop tailored
solutions for
individual needs.



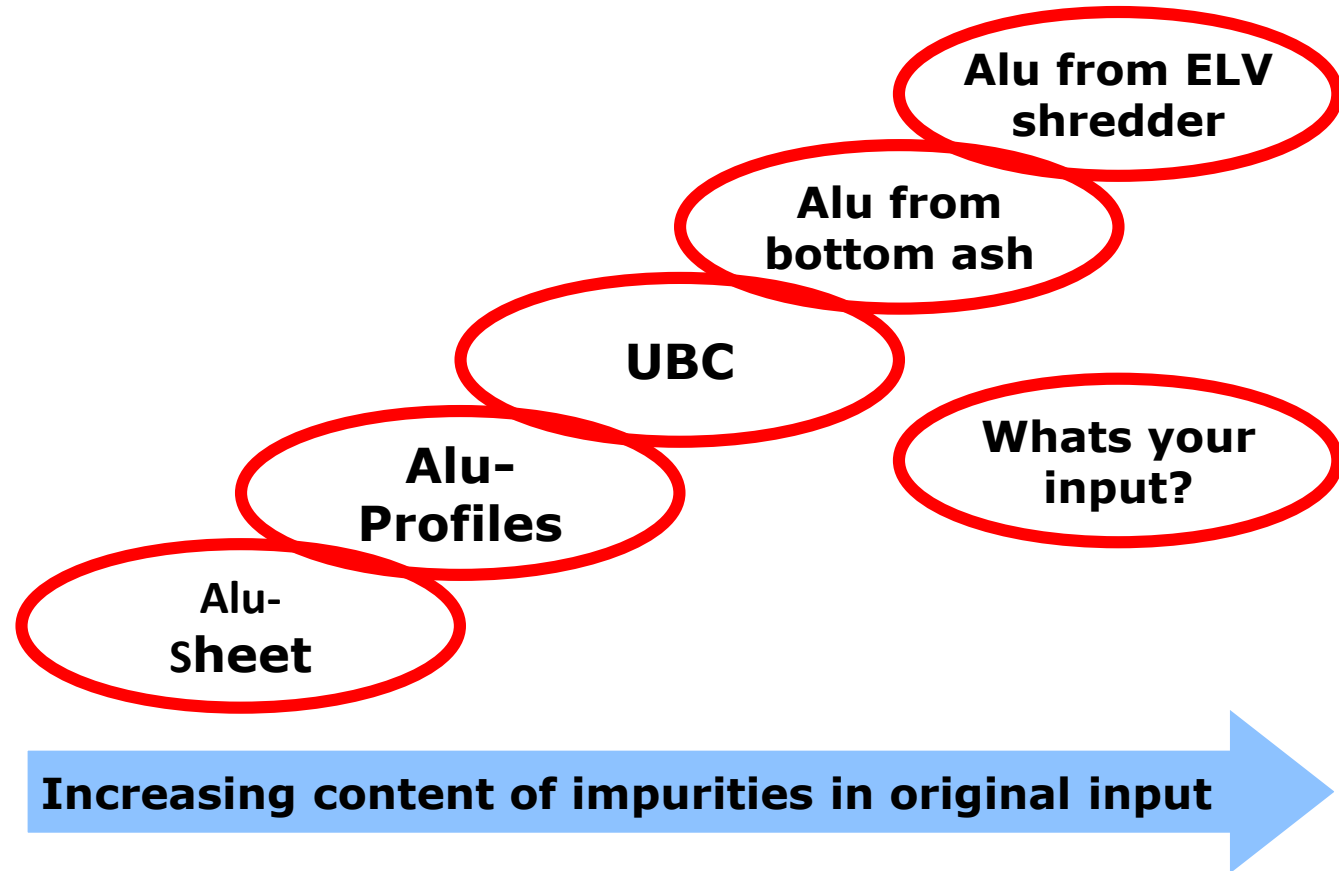
MINING TEST CENTER
in Hamburg, Germany



ALUMINUM SORTING APPLICATIONS

**WASTE
INTO  VALUE**

THERE ARE MANY DIFFERENT ALUMINUM SCRAP SOURCES THAT HAVE QUITE DIFFERENT LEVEL OF COMPLEXITY



TOMRA SORTING HAS TECHNOLOGIES FOR MULTIPLE APPLICATIONS IN DIFFERENT ALUMINUM BUSINESSES



Different applications of TOMRA Sorting units in the Aluminum Industry

- Zorba Sorting:
 - Removing of Heavy metals form Zorba – clean, mixed aluminum material
 - Removal of alloyed aluminum materials - reduction in e.g. Zn content
 - Separation of wrought aluminum from cast aluminum
- Taint Tabor Sorting
 - Revomal of free Heavy metals from Taint Tabor
 - Removal of 2.xxx and 7.xxx alloys – reduction in Cu and Zn content
- Prodcution alloy sorting
 - Sorting of 5.xxx and 6.xxx production stamping alloys
 - Different alloy sorting 1-7xxx groups for clean scrap

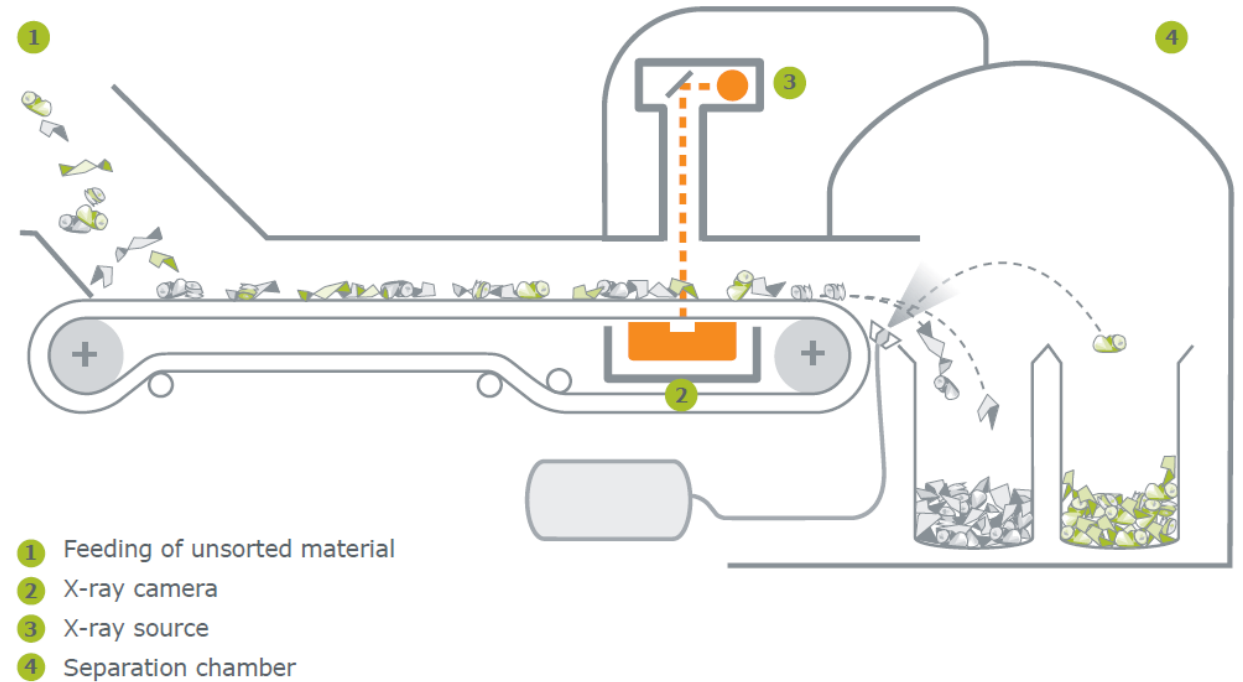
Over 40 TOMRA Sorting units in aluminum segments in operation today.



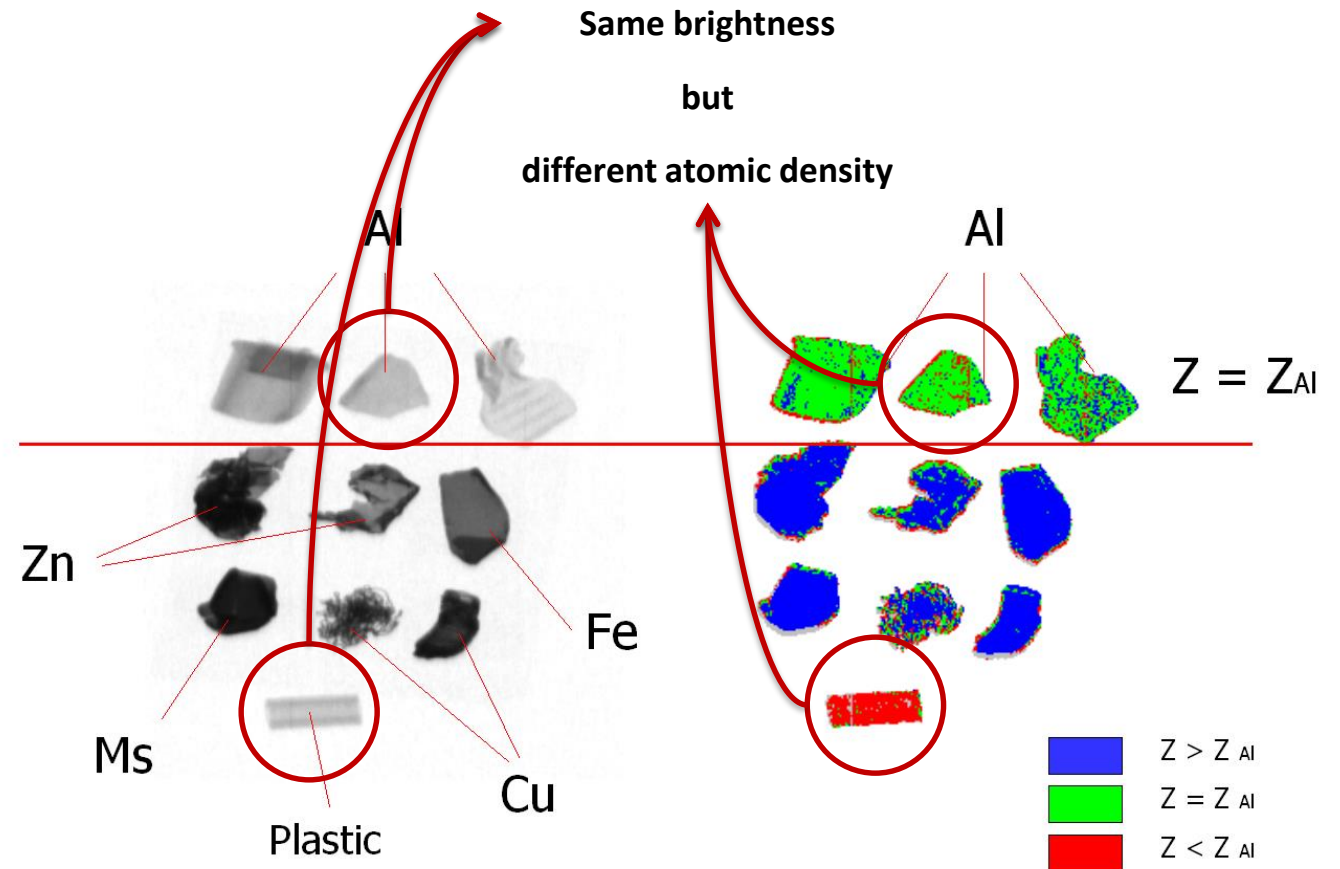
SORTING PRINCIPLE OF SENSOR BASED SORTING ON THE EXAMPLE OF TOMRA'S XTRACT XRT UNIT.

How it works:

- Input stream is feed on a high speed conveyor belt (mono layer)
- Materials on conveyor belt are exposed to X-RAYS and penetrated.
- A sensor system (2 line sensor = DUOLINE) identifies the atomic density, shape, conductivity and other properties and the exact position of each object
- Air jets eject the impurities into a bunker belt
- The rest fraction (cleaned aluminum) falls into another bunker



XTRACT XRT CAN SEPARATE MATERIALS BASED ON ATOMIC DENSITY



APPLICATION EXAMPLE: ALUMINUM SCRAP PROCESSING, RECOVERY/REMOVAL OF ALUMINUM, ALLOYS AND MIXED HEAVIES



ZORBA SORTING APPLICATIONS

**WASTE
INTO  VALUE**

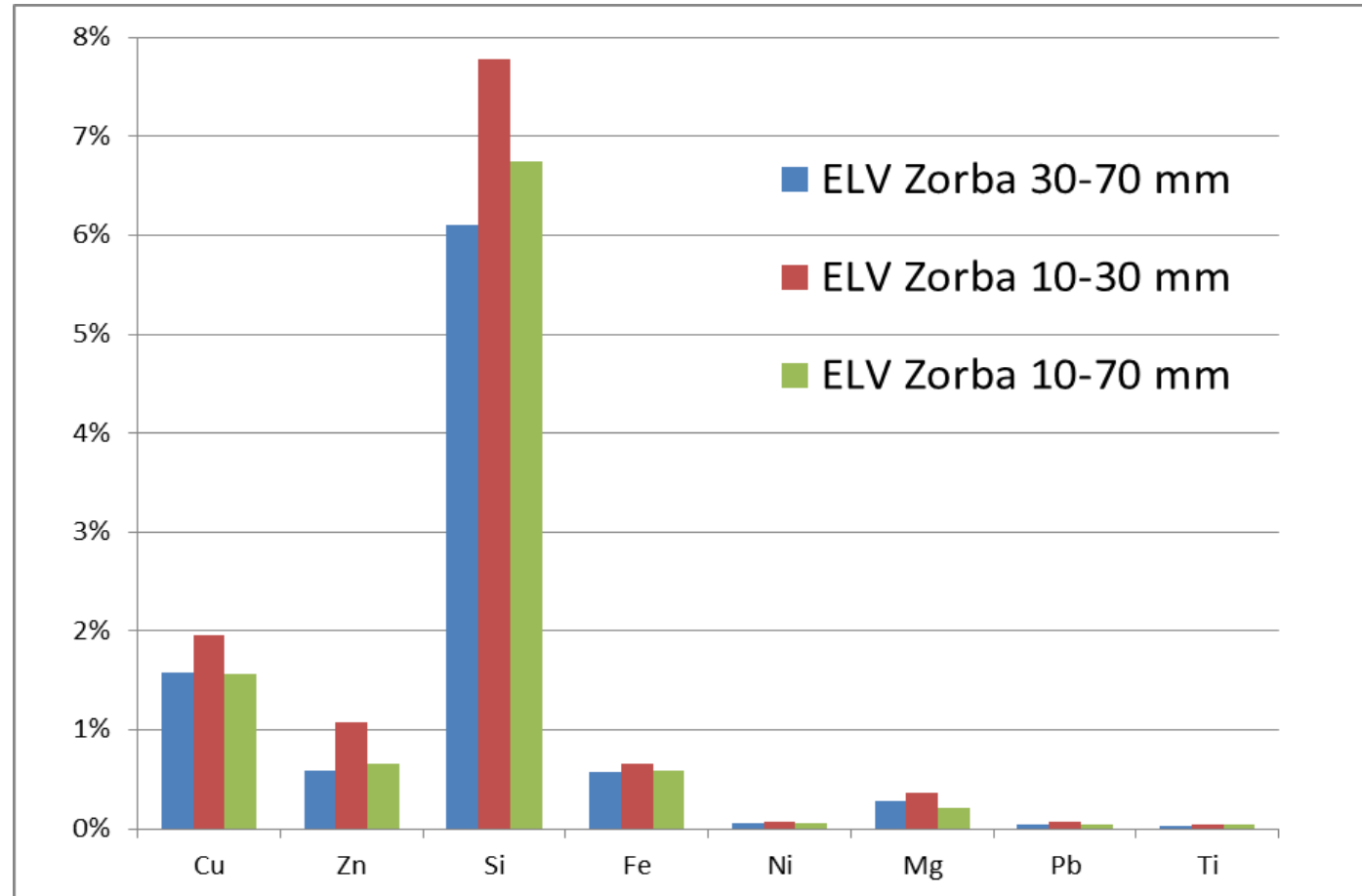
SORTING OF ALUMINIUM (ZORBA) FROM CAR SHREDDER OPERATION; APPLICATION EXAMPLE SORTING BY XTRACT



Frame conditions

- Generation of ELV Zorba by 'traditional' treatment and separation technology.
- ELV Zorba as input material into the density sorting unit
- ELV Zorba to be screened in different grain sizes – small, medium, large
- In example, grain sizes are 10-30 mm, 30-70 mm, 70-110 mm
- Ejection of free heavy metals such as Copper, Brass, Zinc
- Additionally, ejection of high alloyed cast aluminum (e.g. > 2-3% Zn content)
- Aluminum purity by hand sorting (manual counting) is approx. 97-99%

PURITIES OF FINISHED ALUMINUM PRODUCTS IN THE DIFFERENT GRAIN SIZES



WITH SENSOR BASED SORTING IT IS POSSIBLE TO REGAIN A WROUGHT ALUMINUM FRACTION FROM ZORBA

- Aluminum fraction from previous ZORBA sorting can be split further into 'cast' and 'wrought' fraction
- Grain sizes separation upfront necessary
- Main content of wrought is in larger grain sizes
- Classification of material by X-Ray Transmission technology
- Separation by atomic density mainly
- Eventually, need for second sorting step.



Aluminum cast + alloy + polymer



Aluminum wrought product



TAINT TABOR & EXTRUSION SORTING APPLICATIONS

TODAY
INTO 
TOMORROW

REMOVAL OF CU/ZN AL ALLOYS TO ENSURE HIGH QUALITY RECYCLING OF TAIN TAVOR

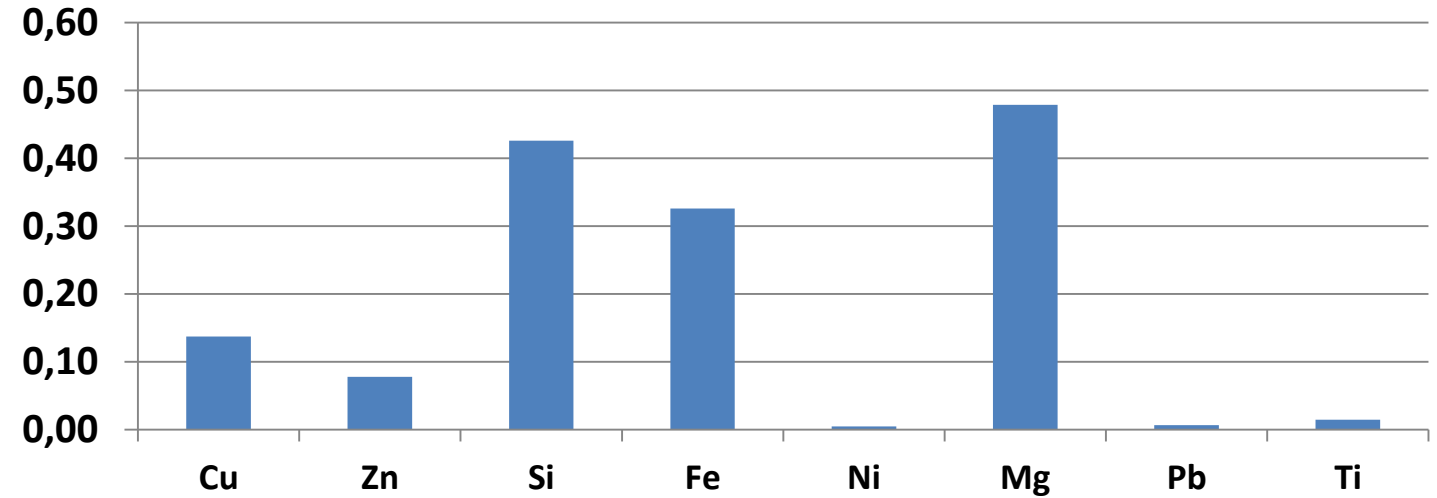
- Trend of upgrade various Aluminum scrap materials, for example sheet rich Taint Tabor scrap
- Focus for recycler/metal producer is to substitute “virgin” or top qualities by upgrade of “lower” qualities.
- There for, reduction of downcycling and at same time saving in material costs.
- Sorting task is the reduction of free heavy`s and high alloy Aluminum such as 2.xxx and 7.xxx



CONTENT OF DIFFERENT METALS IN ALUMINUM SHEET PRODUCT PRODUCED BY XTRACT



Heavy Metal content in Al product



INCINERATOR BOTTOM ASH SORTING APPLICATIONS

**WASTE
INTO  VALUE**

SORTING OF ECS BOTTOM ASH PRODUCT BY X-RAY TRANSMISSION YIELDS WROUGHT ALUMINUM PRODUCT



Frame conditions and findings:

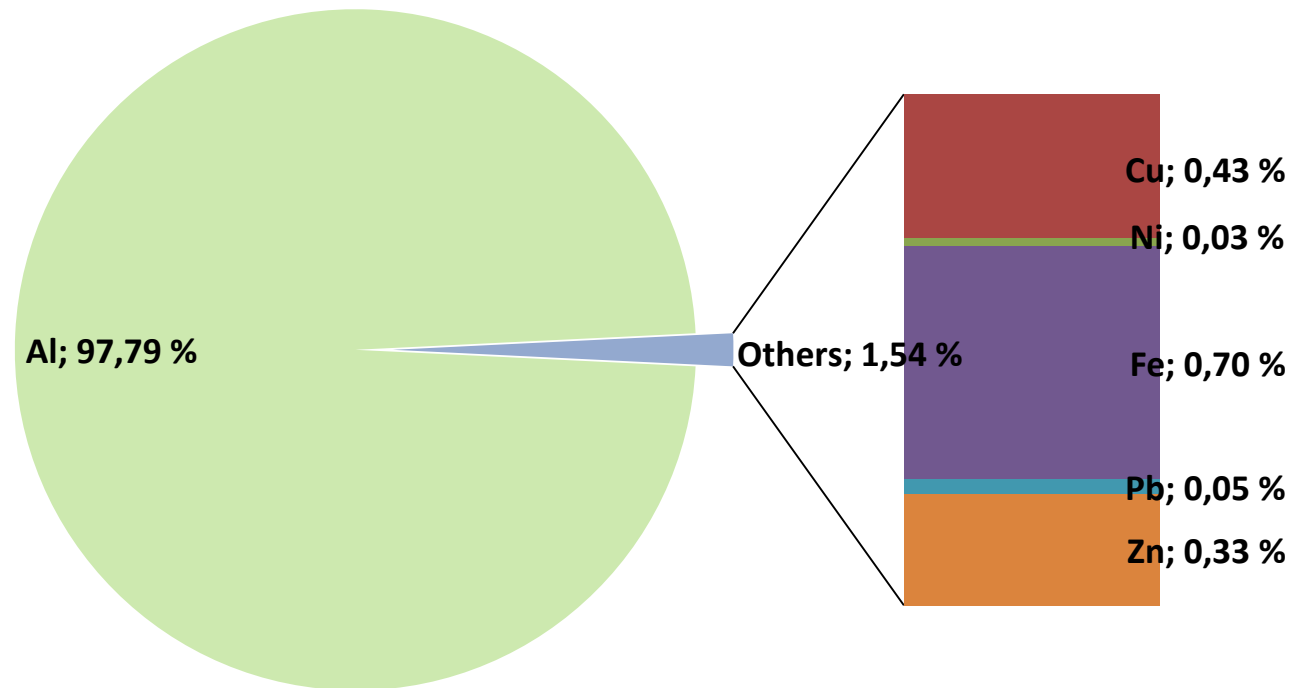
- Traditional bottom ash treatment yields Aluminum rich Eddy Current Product
- Sorting of ECS product – removal of heavy metals by XTRACT
- Grain sizes to be sorted 4-8 mm, 8-12 mm, 12-25 mm & 25-50 mm
- Precious metals are concentrated in grain size <25/30mm
- Aluminum from ashes is a quite nice wrought Alu product



MELT RESULT OF FRACTION SORTED BY SENSOR BASED SORTING SHOWS HIGH ALUMINUM PURITY



XRF Analysis light fraction sample



PRODUCTION SCRAP SORTING APPLICATIONS

TODAY
INTO 
TOMORROW

ALUMINUM USAGE IN THE PRODUCTION OF AUTOMOBILES IS STEADILY INCREASING

- Aluminum usage in cars increasing; from 115 kg (250 lbs.) in 2000 to 235 kg (520 lbs.) in 2025*
- Worldwide (light) vehicle production is 90.000.000 units/year
- Globally, 34% of the vehicle fleet will be electrified by 2025* which will lead to lower consumption of aluminum cast alloys
- CO₂ emission regulations are tightening up, examples
 - EU 28 2015: 130 g/km, 2021: 95 g/km
 - US 2016: 36.2 mpg, 2025: 54,5 mpg (150 g/km; 100 g/km)
 - China 2015: 6.9 l/100 km, 2020: 5.0 l/100 km (160 g/km; 116 g/km)
- Major contributors for CO₂ decrease are**
 - Powertrain Efficiencies – e.g. 5-8% CO₂ reduction by cylinder deactivation = 8 g CO₂/km reduction
 - Aerodynamics and energy management – e.g. 1% CO₂ reduction by 2% drag reduction
 - **Lighthweighting – e.g. 50 kg weight reduction = 5 g CO₂/km reduction**

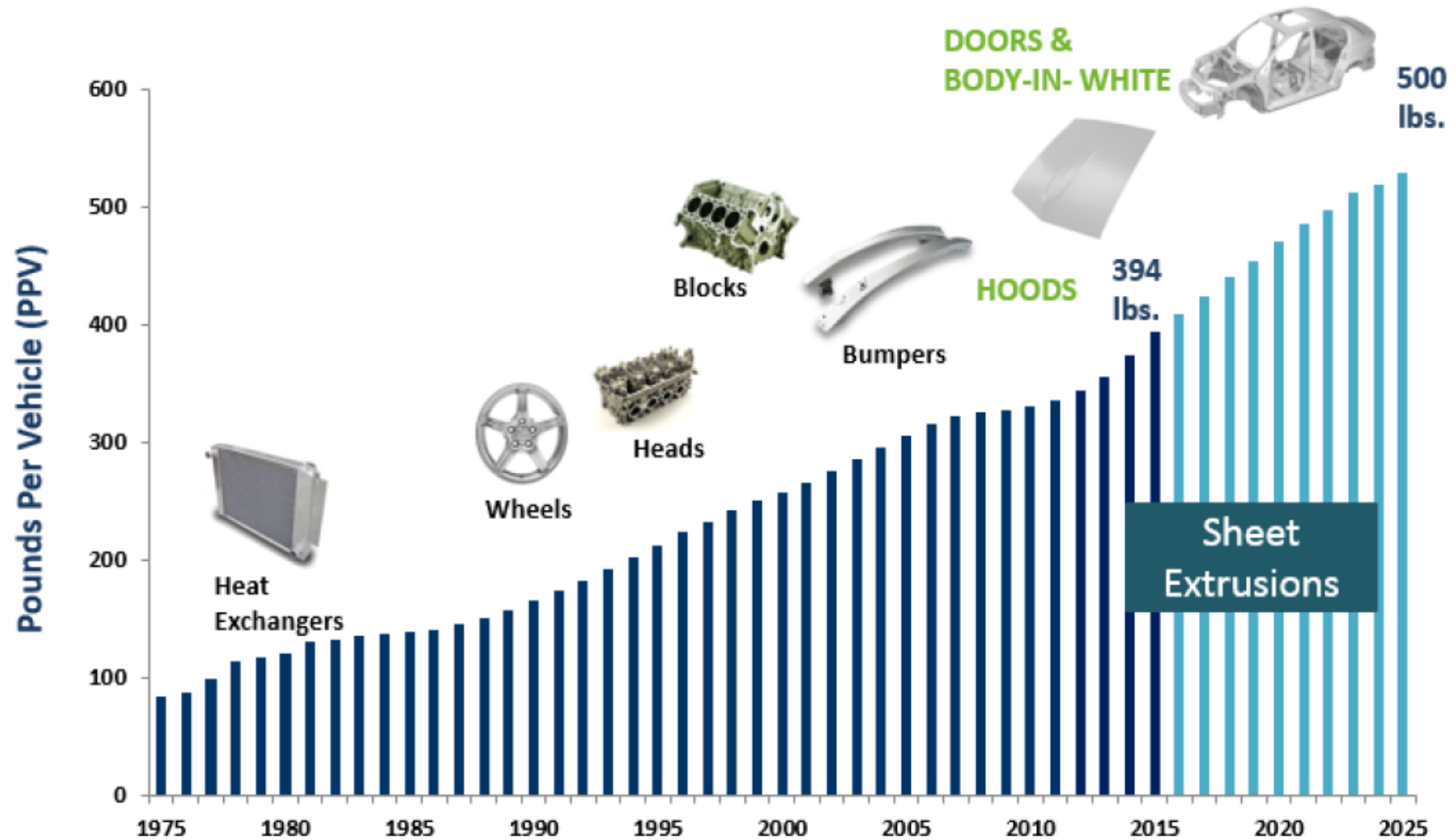
CONCLUSION: More aluminum usage by lighthweighting BUT less aluminum usage by casting engine blocks!



*Ducker Study, 2015

**IHS Markit – 2017 Fall Automotive Conference; Frankfurt

USAGE OF ALUMINUM CAST AND ALUMINUM SHEET MATERIAL IN THE CAR INDUSTRY



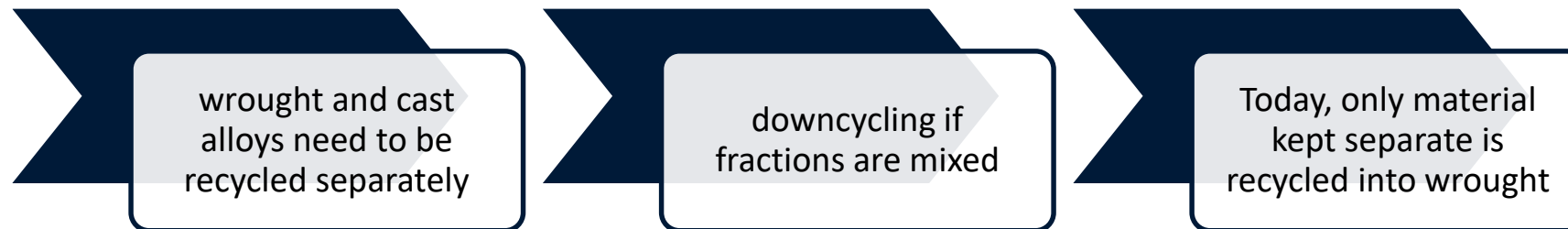
Source: 2015, Ducker Worldwide



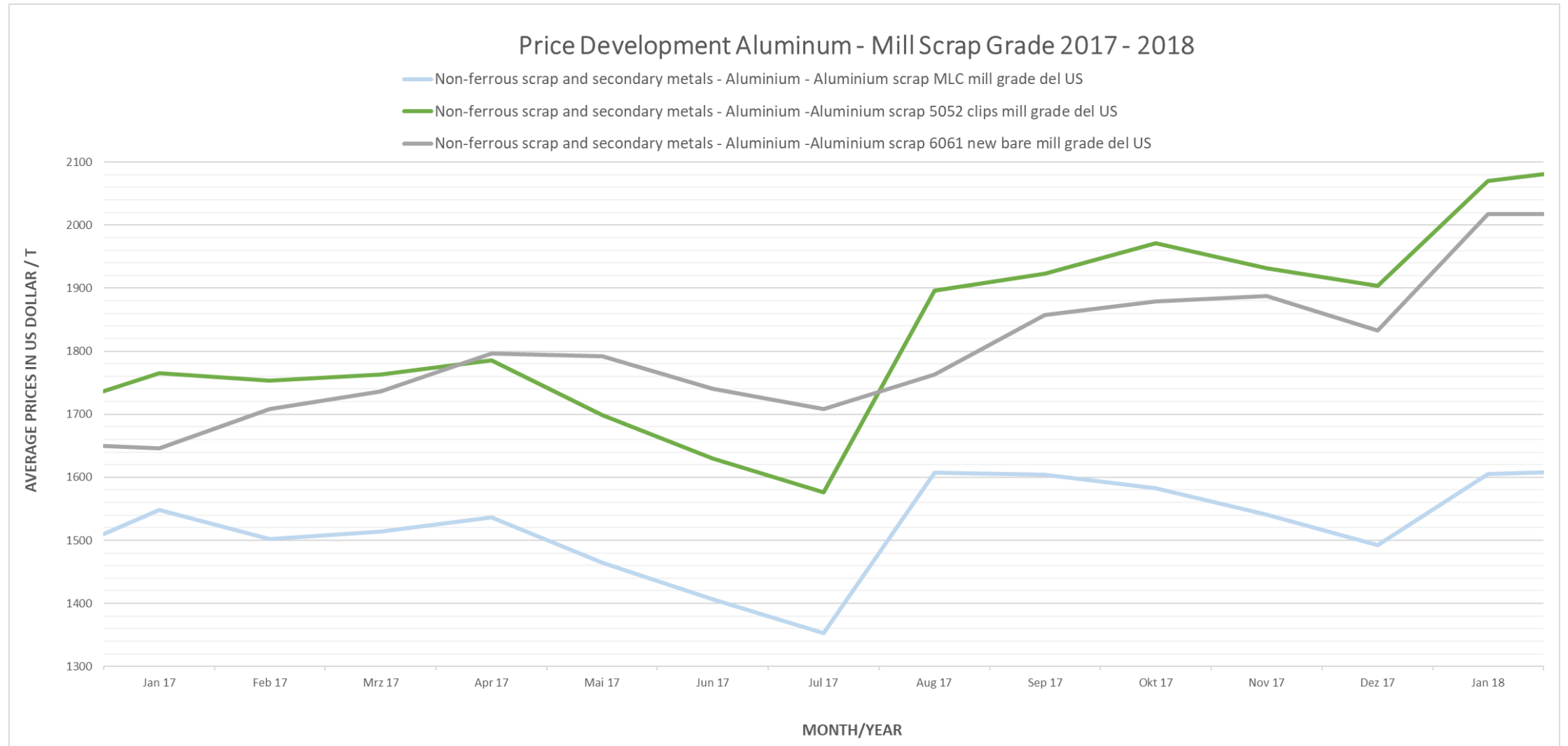
CHALLENGES WITH RECYCLING

- Aluminum bonds tightly with other elements
 - Only limited possibilities to remove alloying elements metallurgical
 - Influencing composition of molten (secondary) aluminum is blending/dilution with primary aluminum.
- Wrought alloys and cast alloys differ significantly in composition:
 - Cast alloys – main alloying elements Si, Zn and others; significant amount
 - Wrought alloy – main alloying elements Mg, Si; viewer percentages
 - Due to high alloy amounts in cast; fractions that are ‚contaminated‘ by cast alloys can not be used for the production of new wrought materials
- Wrought alloys sub-divide into 8 different groups; group definition by alloying element

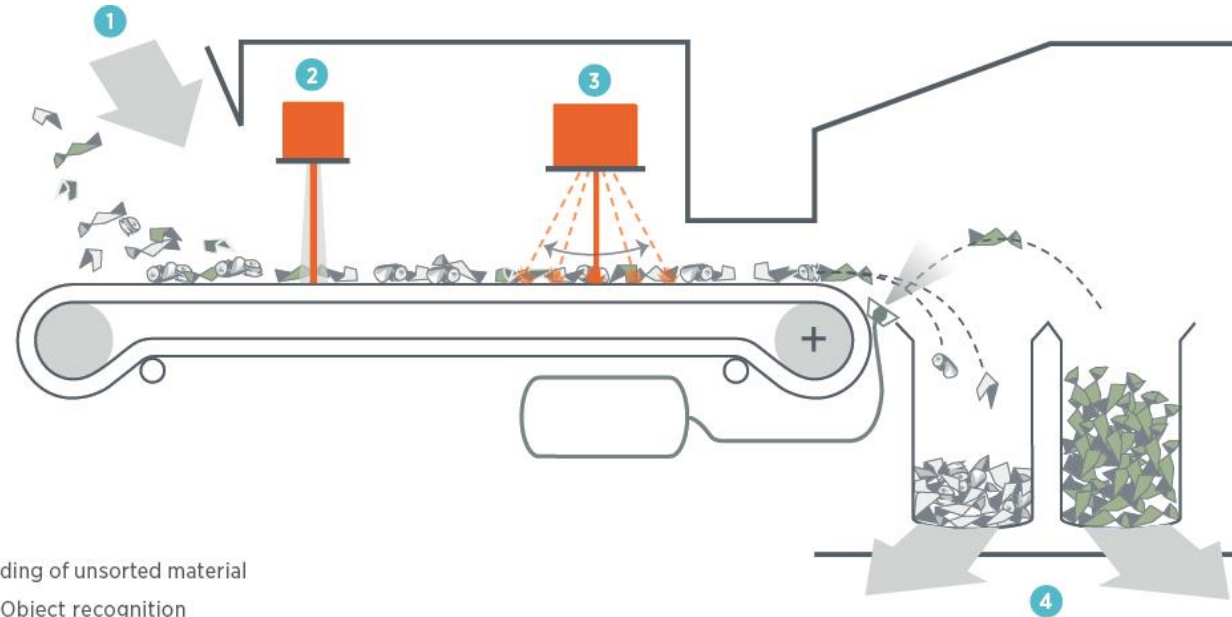
Conclusions:



PRICE DEVELOPMENT ALUMINUM SCRAP



HOW DOES TOMRA'S LIBS SYSTEM WORK?



- 1 Feeding of unsorted material
- 2 3D-Object recognition
- 3 Scanning/LIBS analysis
- 4 Separation chamber

Singulation

- Particles can be fed randomly to conveyor belt
- Conveyor belt runs at 3 m/s



3D/Surface Detection

- 3 D analysis (scanning)
- Computer identifies right position for laser



Cleaning/Analyzing

- Same laser targets particle for both steps
- Laser is focused by dynamic mirror system



Ejection

- Ejection of particles into two fractions
- Ejection by means of air jets



TOMRA SORTING LIBS TESTSYSTEM IN KOBLEN TEST CENTER



EXAMPLE 1: SORTING OF 6XXX FROM 5XXX

Input	kg	
Total	6,31525	100%
Composition (calculated)		
5xxx	4,6625	73,8%
6xxx	1,65275	26,2%
Sum	6,31525	100%

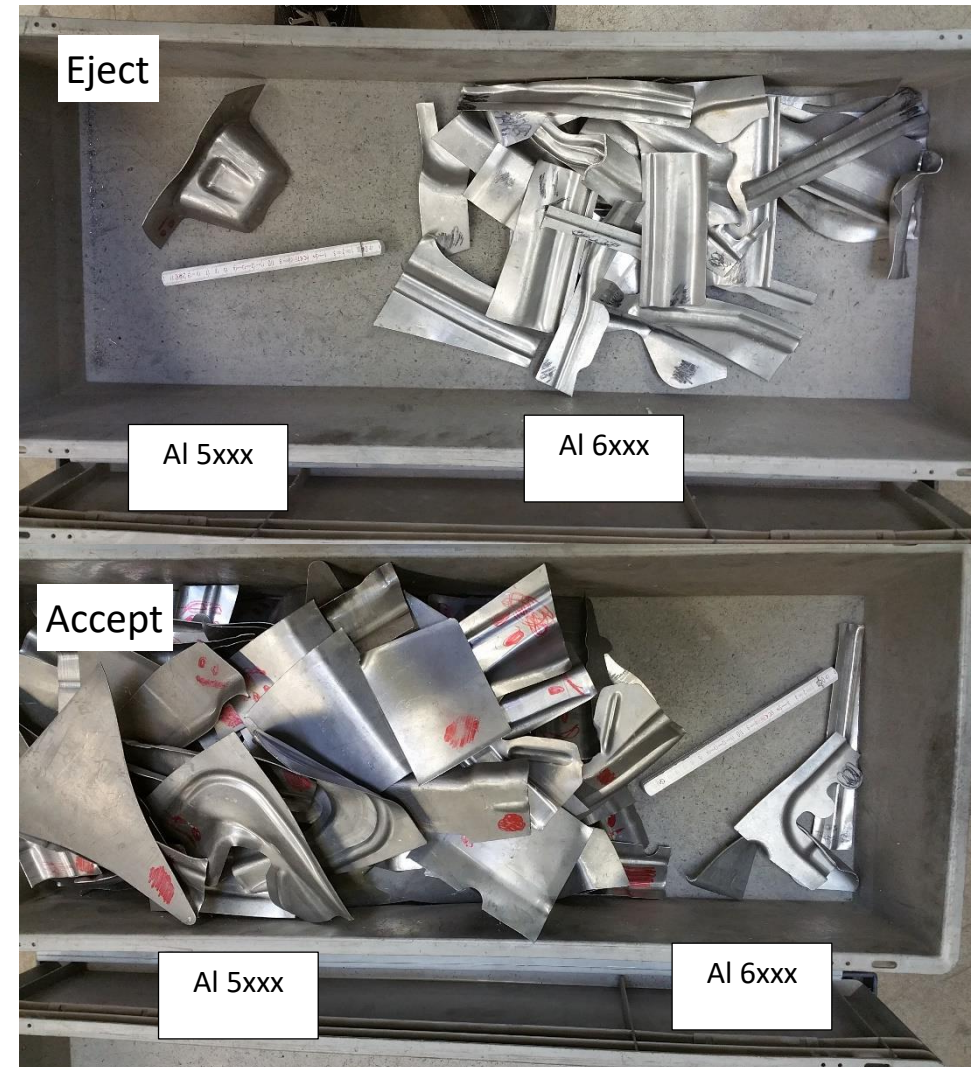
EJECT
Step

Accept

Material	kg	
Total	4,588	73%
Composition		
5xxx	4,52225	98,6%
6xxx	0,06575	1,4%
Sum	4,588	100,0%

Material	kg	
Total	1,72725	27%
Composition		
5xxx	0,14025	8,1%
6xxx	1,587	91,9%
Sum	1,72725	100,0%

Recovery 5xxx: 97,0%
Recovery 6xxx: 95,8%



SENSOR BASED SORTING CAN SUPPORT AND ENABLE HIGH QUALITY RECYCLING OF DIFFERENT ALUMINUM SCRAP SOURCES



Summary

- Different scrap sources can today be separated in higher quality fractions that can be recycled in a high quality application
- Down-cycling of valuable aluminium alloys can be reduced by sensor based sorting
- Usage of virgin material resources can be reduced by sorting the scrap materials with sophisticated sorting technologies
- Risk of aluminum scrap usage for recyclers can be reduced
- Viewer need of blending and melt corrections
- In future, sorting of production scrap as well as old scrap into alloy group or eventually separate alloys will be possible

WASTE INTO VALUE

www.tomra.com/recycling