



# SENSOR BASED SORTING



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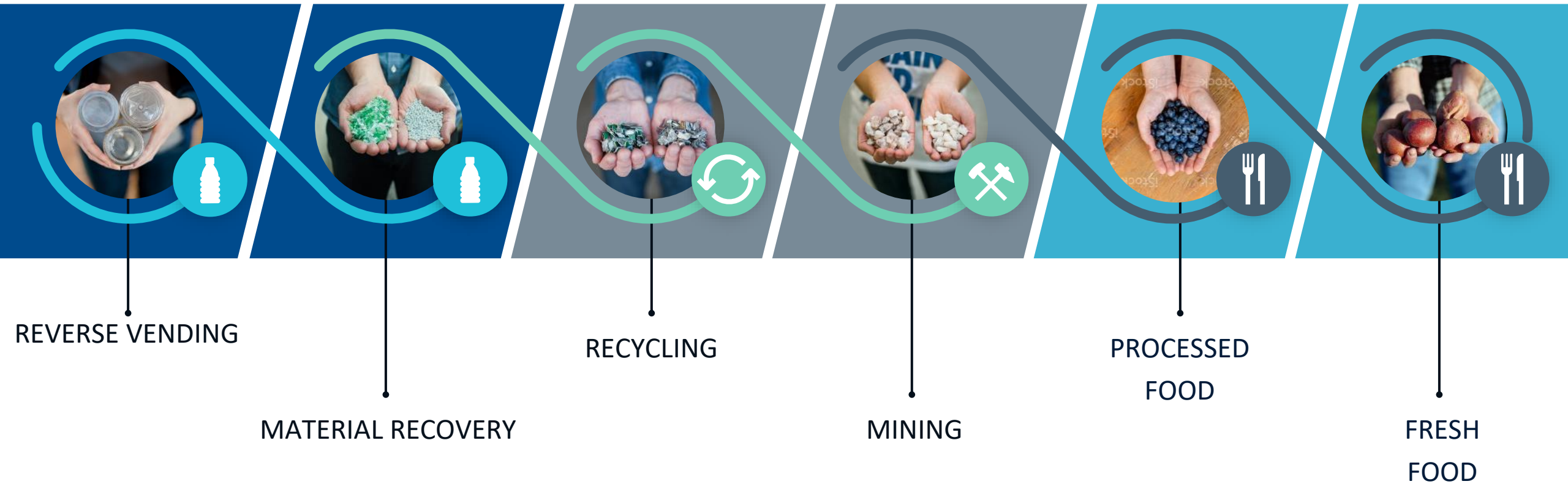
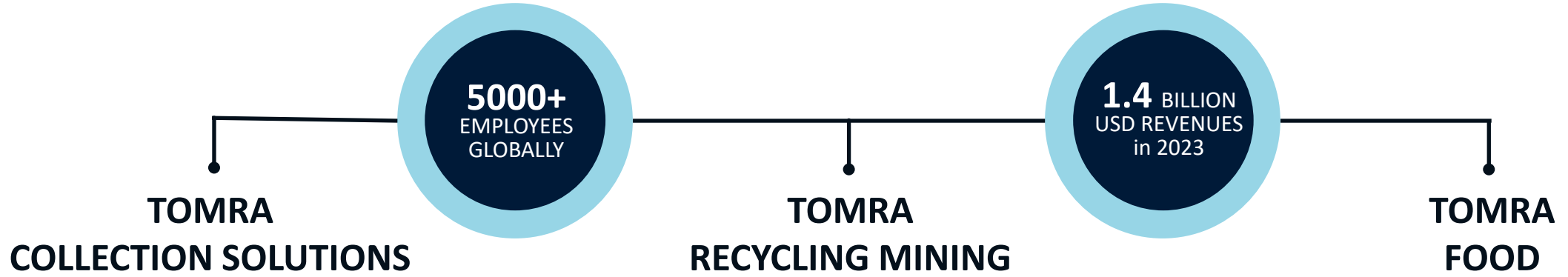
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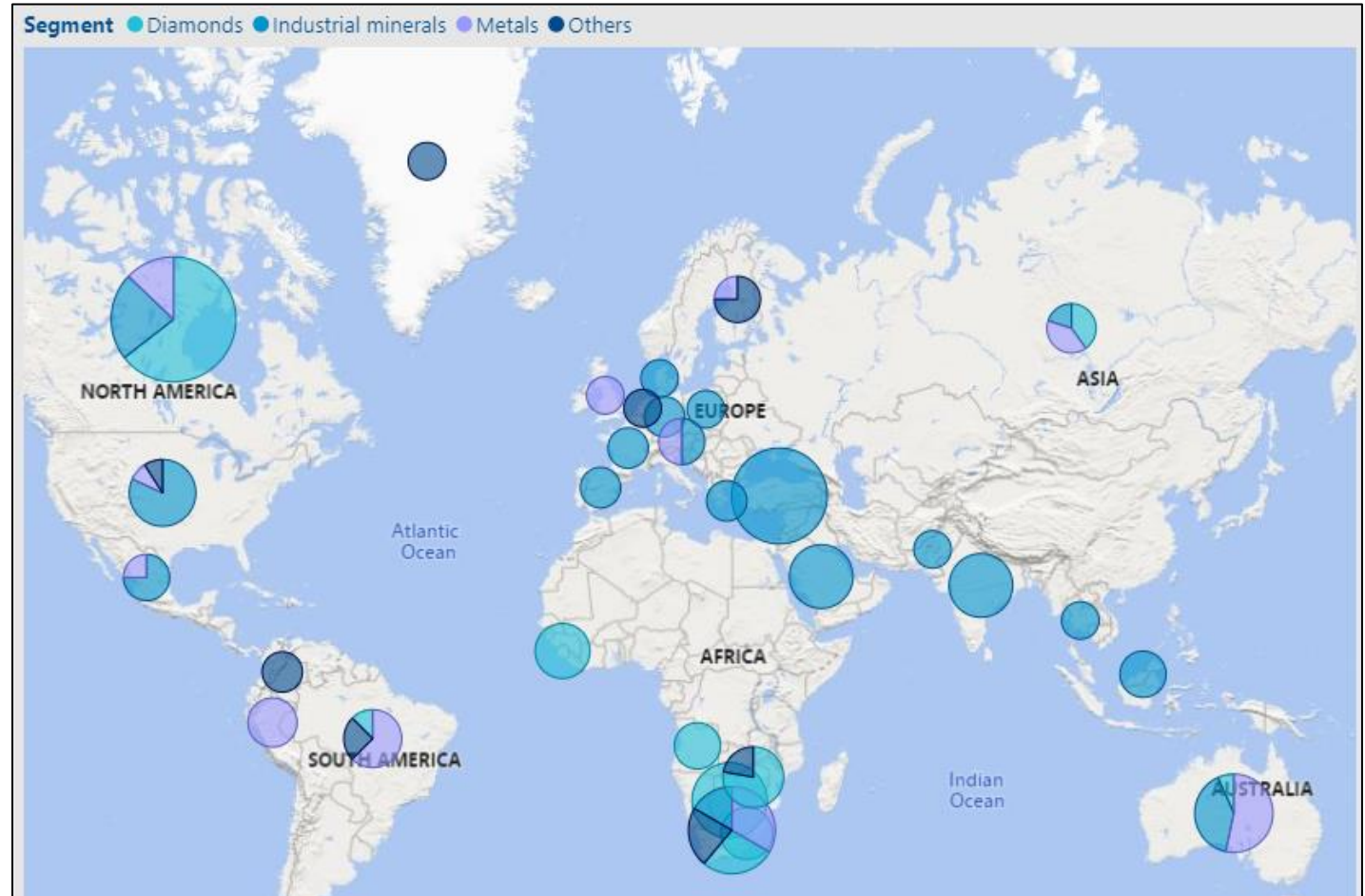
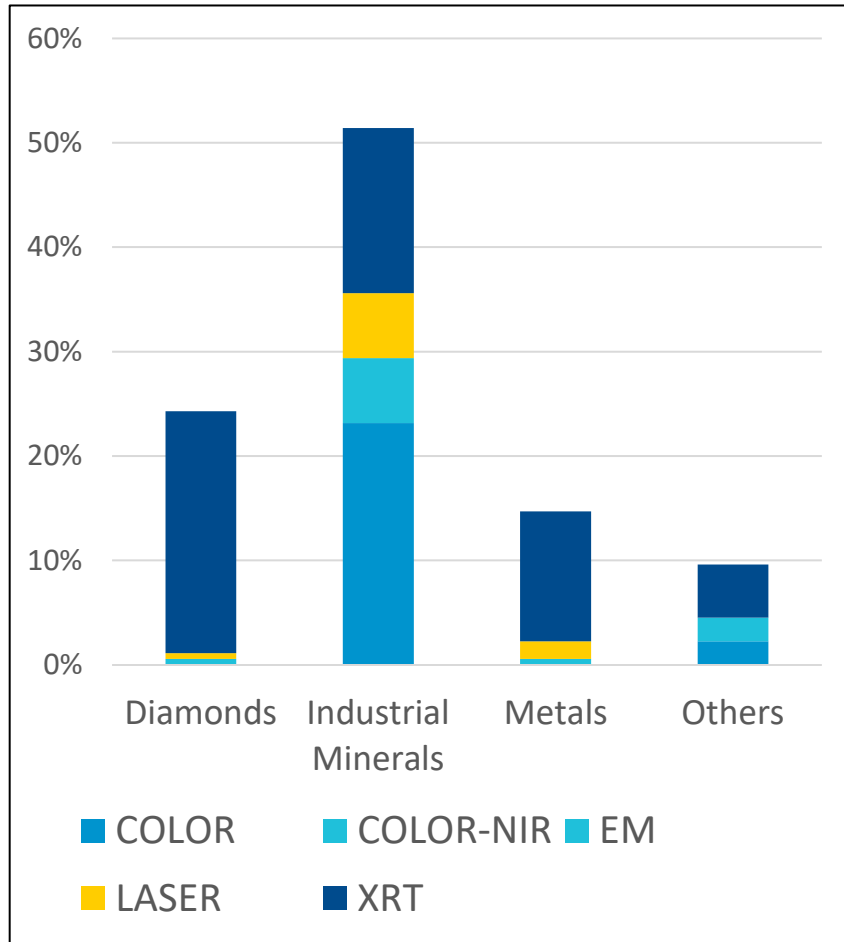
# CONTENTS

**TOMRA Overview**  
**Technology**  
**Applications**  
**TOMRA Digital**  
**Testwork**  
**Site Installations**





# MINING – INSTALLED BASE – 232 SORTERS





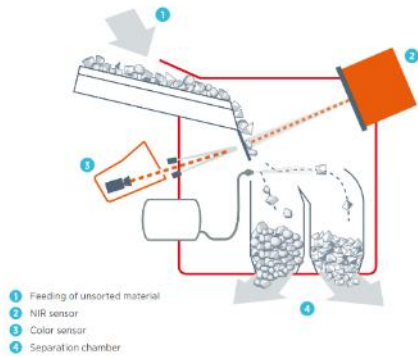


# TECHNOLOGY



# MINING PRODUCT PORTFOLIO

**PRO series**  
(Industrial Processing sorter)



**CHUTE**

**PRO Primary (50–250mm)**  
COLOR / COLOR-NIR



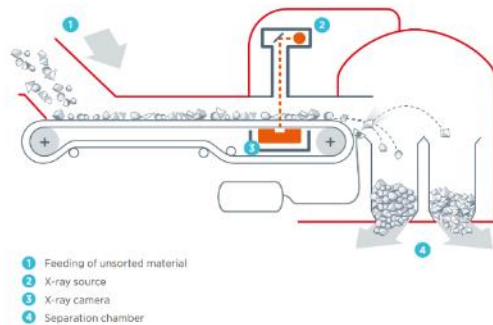
**PRO Secondary (20–120mm)**  
COLOR / COLOR Dual / COLOR-NIR  
LASER / LASER Dual



**PRO Tertiary (2-32mm)**  
COLOR / LASER



**COM series**  
(Common belt sorter)



**BELT**

**COM XRT 2.0**  
(20-100mm)



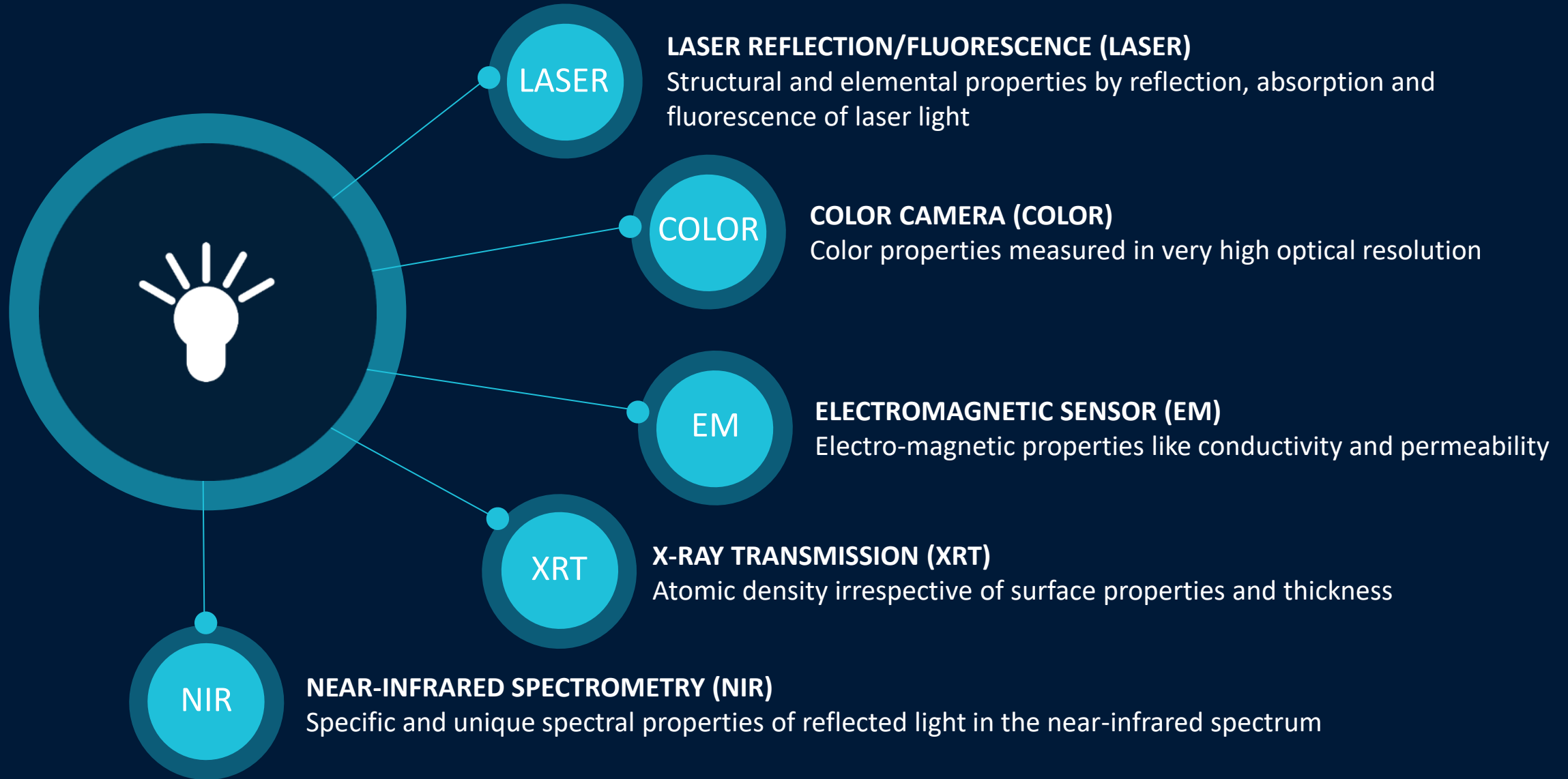
**COM Tertiary XRT**  
(6-60mm)



**COM XRT 300**  
(2-32mm)



# MINING SENSOR PORTFOLIO





# LINK TO VIDEO XRAY SORTER PROCESS FLOW

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<https://video.tomra.com/com-xrt-20-process-animation>

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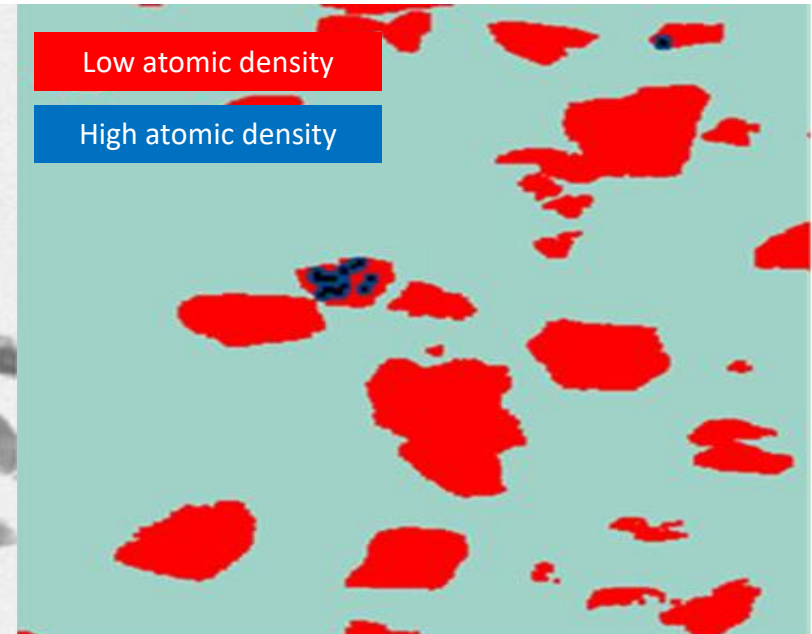
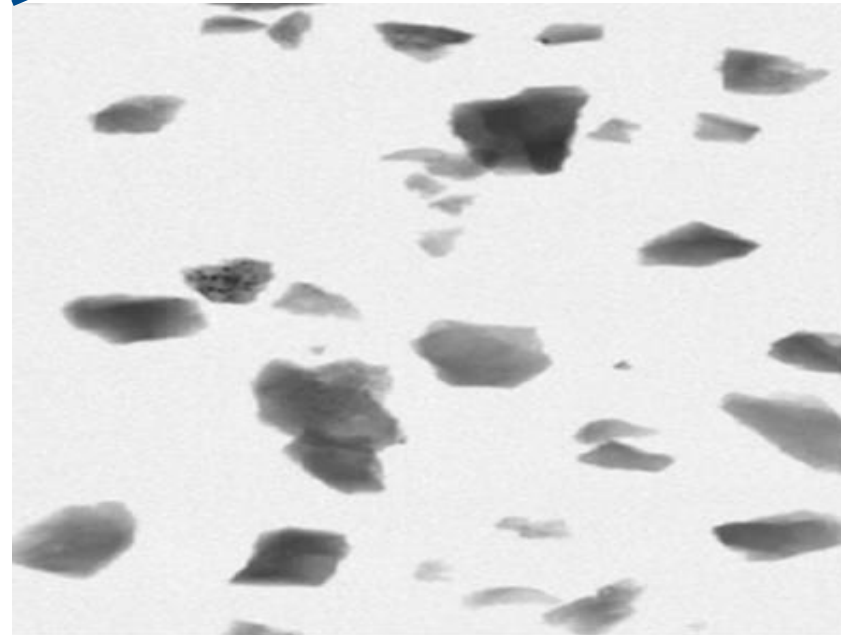
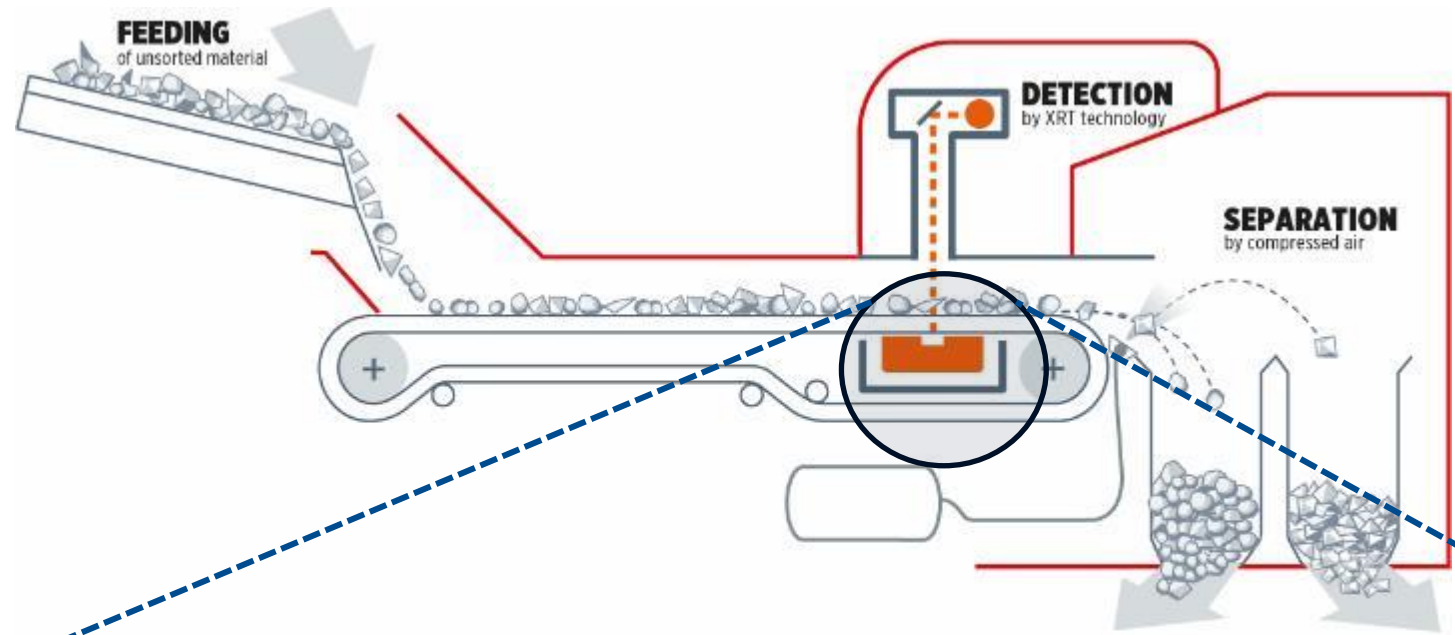
# TOMRA-XRT DETECTION PRINCIPLE

As inside any luggage scanner, the objects are scanned using two x-ray energy levels and differences are made visible by colors.

~5 bags / minute

vs.

up to 400 tonnes /hour



# LINK TO VIDEO LASER SORTER PROCESS FLOW

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<https://video.tomra.com/pro-secondary-laser-process-animation>

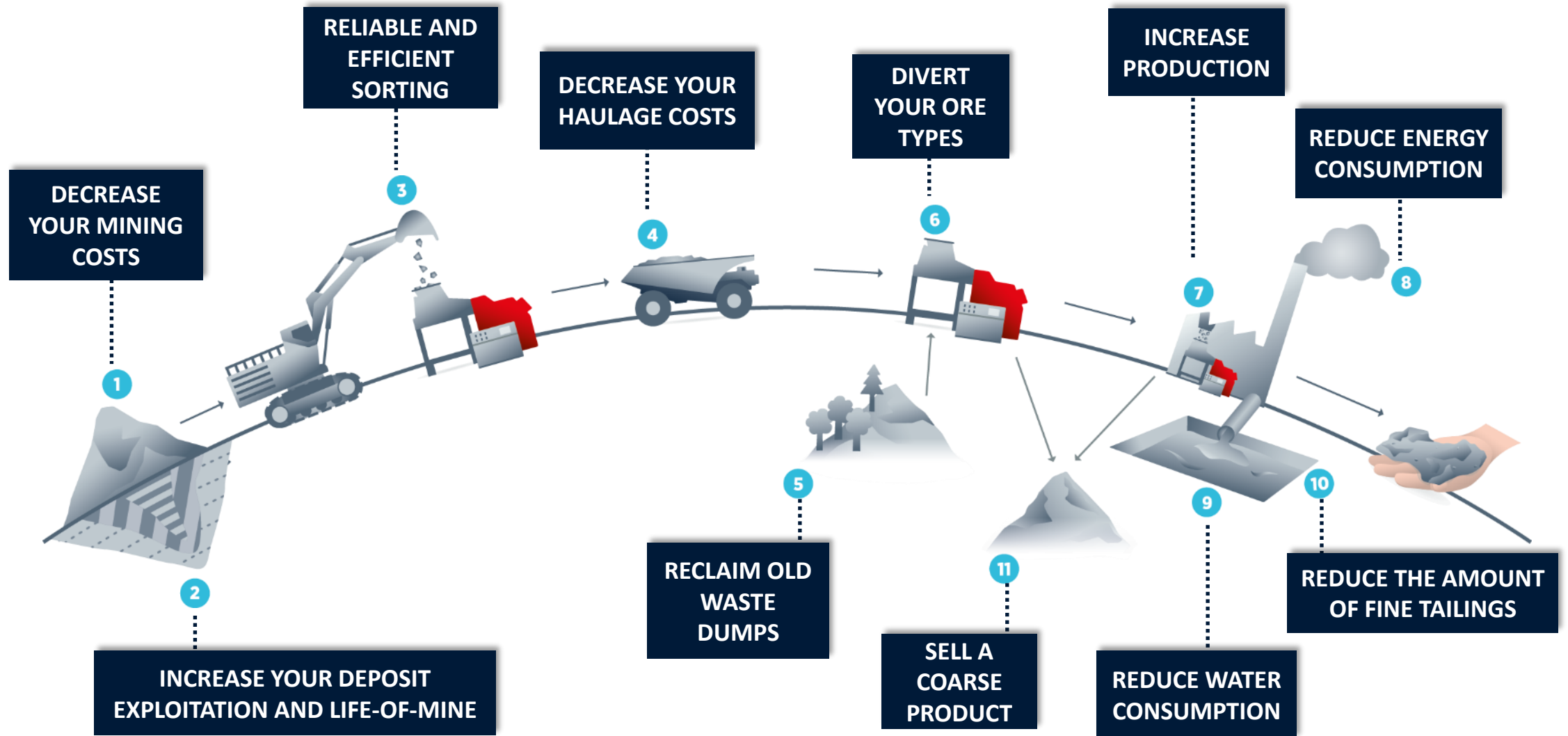
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# APPLICATIONS

# SENSOR-BASED TECHNOLOGY CREATES VALUE IN VARIOUS PARTS OF THE MINING PROCESS





# APPLICATIONS

## Industrial Minerals

Calcite, quartz, feldspar,  
magnesite, talc, dolomite,  
limestone, rock salt,  
phosphates, potash  
**COLOR, XRT, NIR, LASER**



## Diamonds

Diamond recovery, waste  
removal, final recovery, sort  
house  
**XRT, LASER**



## Metal Ores

Copper, zinc, gold, nickel,  
tungsten, silver, platinum  
group metals, iron, manganese, chromite  
**XRT, COLOR, EM, NIR, LASER**



## Others

Different type of slags, other  
gemstones, ...  
**XRT, COLOR, LASER, EM**





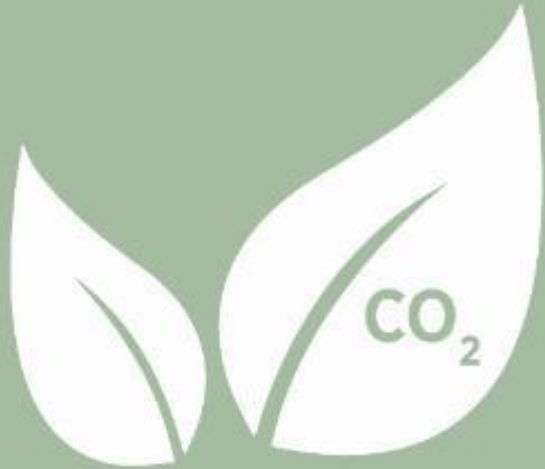
# MINERAL/ELEMENT VS SENSOR

Mineral/Element	Sensor
Antimony	XRT
Chromite	XRT
Copper	XRT, Colour
Diamonds	XRT, Laser
Fluorspar	XRT, Laser, NIR
Gold	XRT, Laser
Graphite	XRT, EM
Iron	XRT
Lead/Zinc	XRT
Limestone	XRT, NIR
Lithium	XRT, Colour, Laser
Manganese	XRT, Laser, NIR
Magnesite	XRT
Molybdenum	XRT
Nickel	XRT

Mineral/Element	Sensor
Phosphate	XRT
Polymetallic	XRT
Potash	XRT
Quartz	Laser, Colour
REE	XRT
Salt	Colour
Silver	XRT
Talc	NIR
Tin	XRT
Tungsten	XRT



**TOMRA  
GREEN COUNTER**



**72.531,477**  
Metric tons saved\*

\*Total amount of CO<sub>2</sub> saved since  
January 1, 2020 by sorting machines  
currently installed by TOMRA MINING.

144.937,155 Metric tons saved in 2019

# ORE SORTERS CAN:

- SAVE ENERGY/CRUSHING/GRINDING
- PRODUCE NAF AND PAF
- HELP WITH REHABILITATION
- REDUCE ENVIRONMENTAL FOOTPRINT OF MINING
- EARLY STAGE DRY PRECONTRACTION THROUGH SORTING SAVES... EVERYTHING

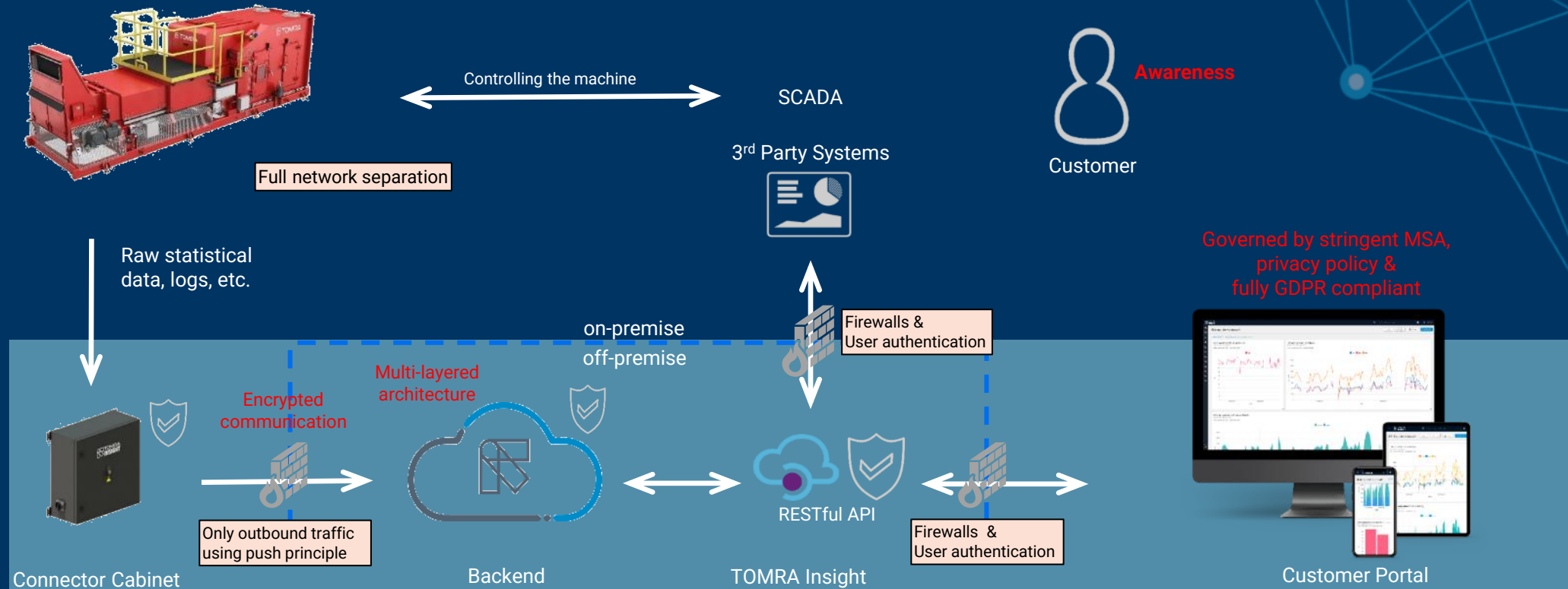


# TOMRA DIGITAL



# TOMRA Insight – Secure Access to Data

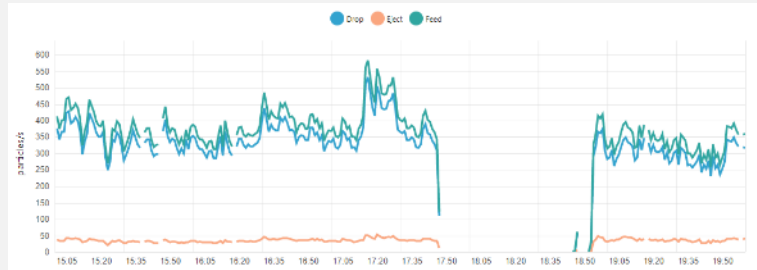
Secure access to raw statistical data and performance indicators is available via the TOMRA Insight API



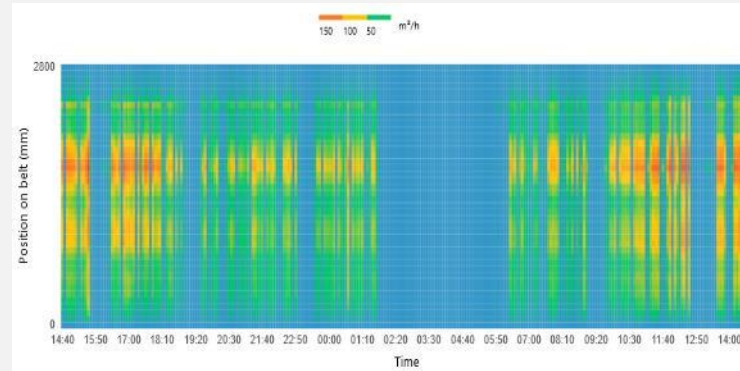


## Useful information and features provided by TOMRA Insight

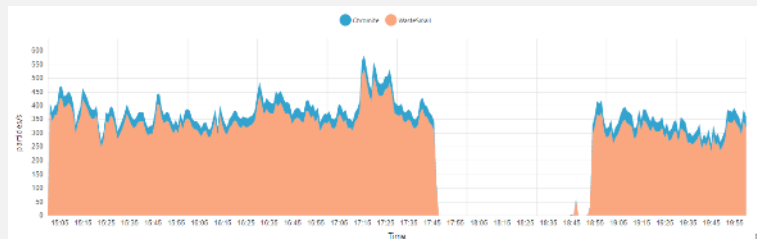
### Run at design capacity



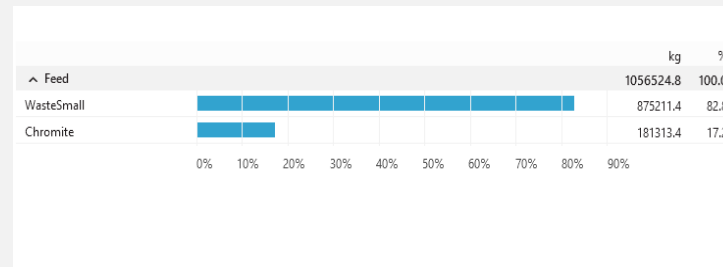
### Material distribution on conveyor



### Monitor feed properties



### Meet production targets



## Work targets

- Ensuring the plant is running **efficiently** with **minimum downtime**
- Keeping the **team safe, motivated** and **productive**

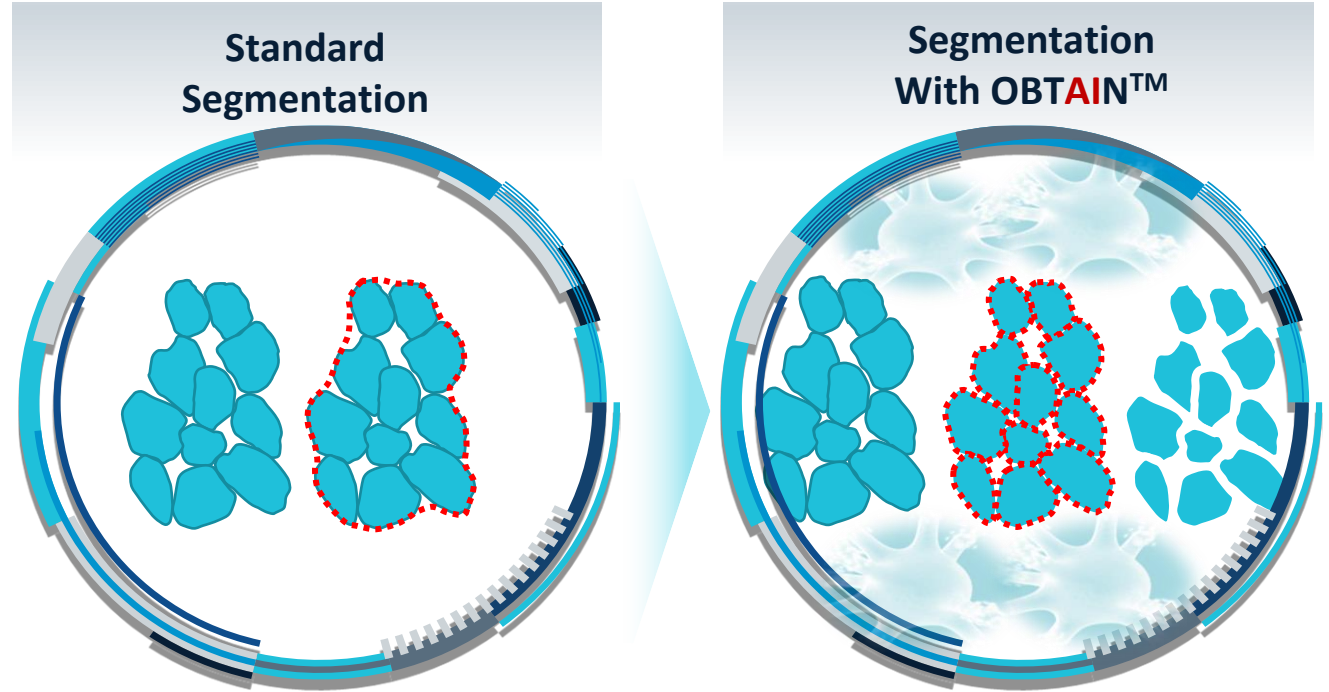




# MOTIVATION

NEW FEATURE DEVELOPMENT

# OBTAIN™



## Why?

- Sorting performance depends on a good particle singulation
- Particle singulation on a conveyor belt depends on the mechanical infeed setup, throughput, application, ...
- The higher the throughput the more particles are touching each other

## What?

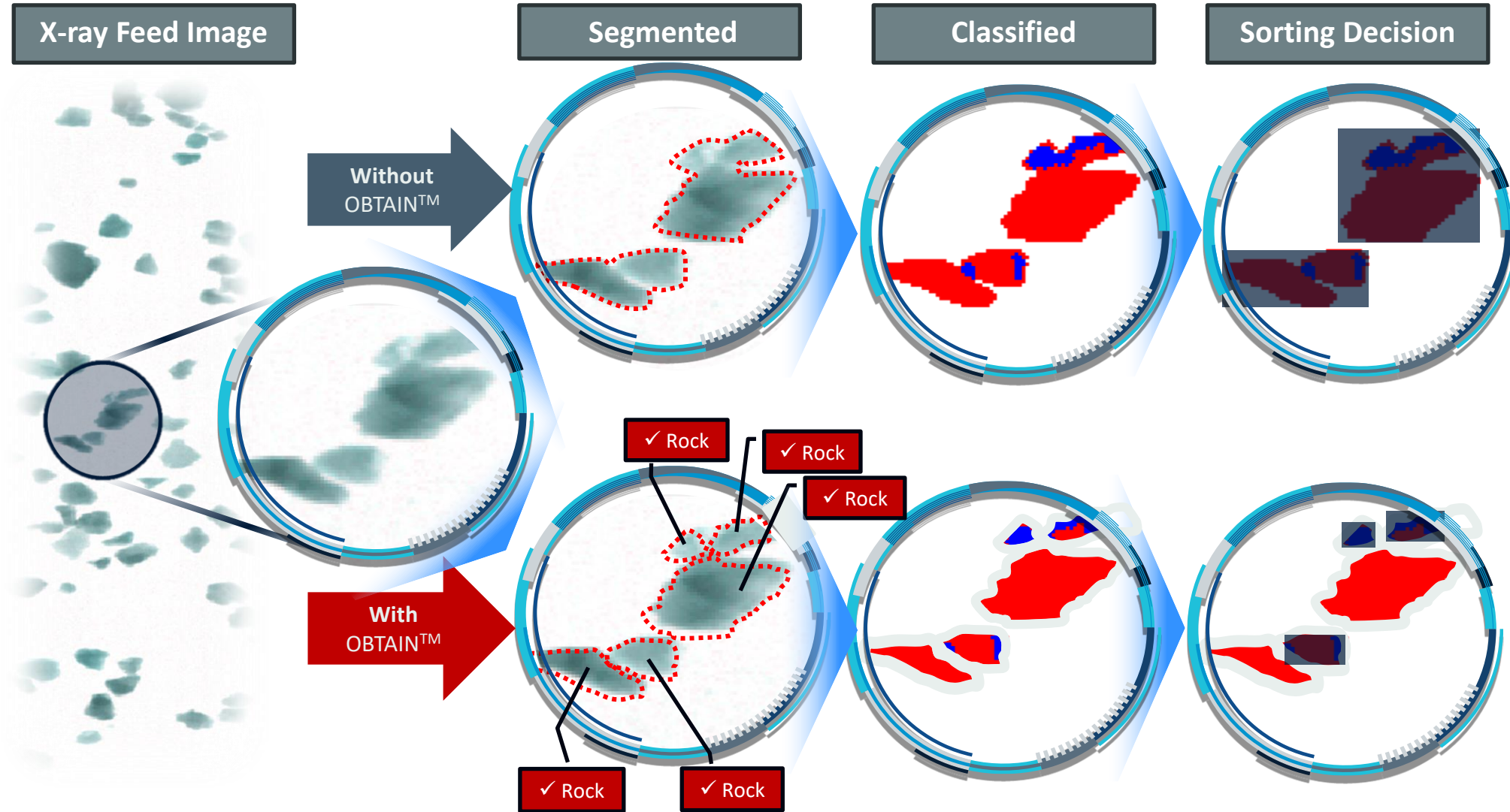
- Stable sorting performance independent of physical material singulation
- Improve sorting efficiency by increased detection precision
- Increase tonnages (belt occupancies) with same or better sorting results

## How?

- Usage of Deep Learning approach - using artificial neuronal networks (CNNs)
- Network is trained to see single rocks
- Classification is done for each particle independently

# Principle

OBTAIN™







# TESTWORK





# DEMONSTRATING SORTING POTENTIAL

With test centers in Australia, Germany, Canada & South Africa, TOMRA's testwork and application development program includes:



## PROJECT DEFINITION

Initial client consultation and analysis of geological, mineralogical, and process information



## FIRST INSPECTION

- First inspection testwork to check sensor response and material liberation characteristics
- Application development



## PERFORMANCE TEST

- Bulk sample preparation and screening (location dependent)
- Full-scale performance testwork to measure sort quality at agreed cut points, feed rates, and process flow configurations
- Comprehensive technical reporting



## FLOW SHEET DESIGN

Based on the project objectives and environment, TOMRA will assist in the integration of sorters into the process flow and plant design.



**ALL TOMRA TEST CENTERS ARE EQUIPPED WITH FULL SCALE SORTERS IDENTICAL TO THOSE INSTALLED ON SITE.**  
The two stage test program de-risks the scale-up of the technology with the performance testwork carried out on up to 30t of feed material at full capacity.

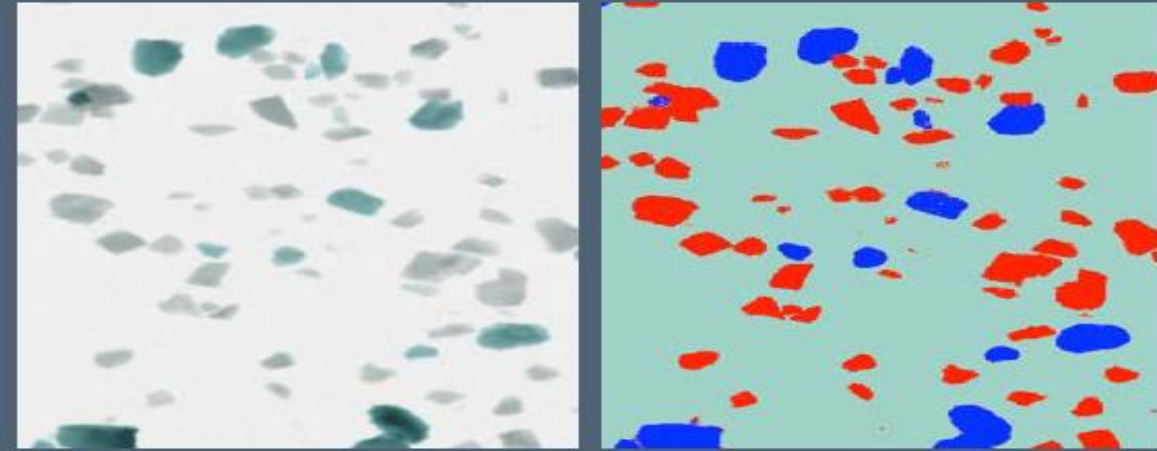


# SORTING TESTWORK AND REPORTING

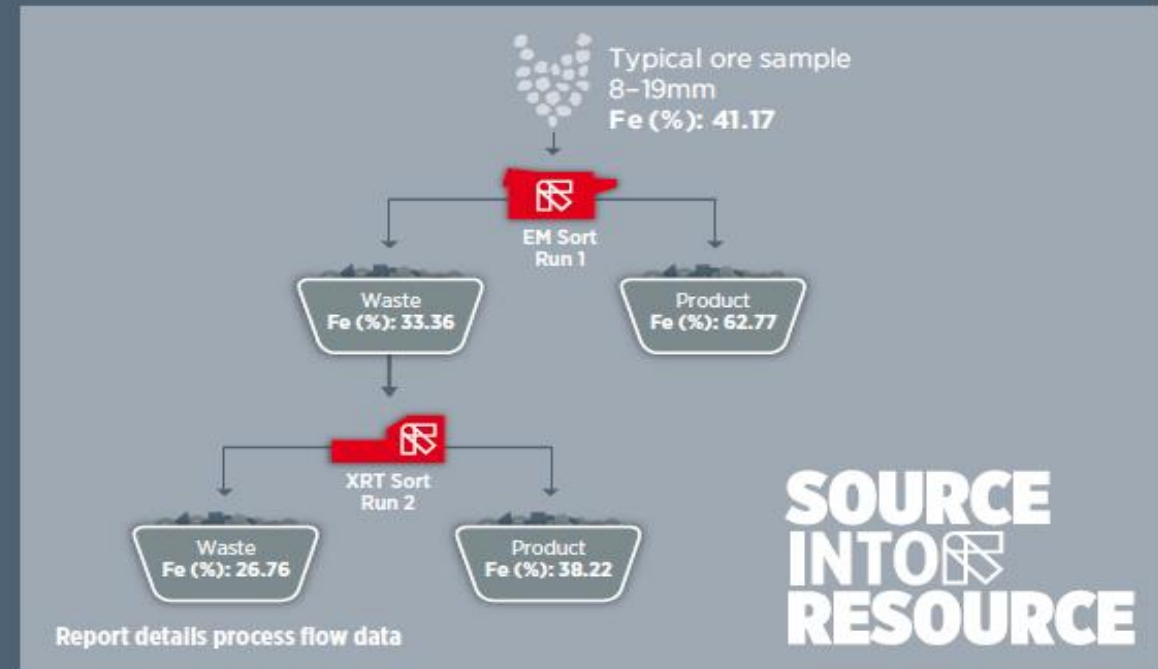


	FIRST INSPECTION	PERFORMANCE TEST
<b>PURPOSE</b>	Small-scale test to determine if the ore is amenable to ore sorting Cannot be used for resource modelling	Full-scale sorting evaluation to establish expected sorter performance Recommended for PFS*, BFS** or FEED***
<b>PARTICLE SIZE RANGE</b>	+8 /-65mm Dependent on ore. TOMRA to advise	+2 /-110mm Dependent on ore. TOMRA to advise
<b>SAMPLE MASS</b>	50-100kg	2-30 tonnes of material depending on testwork process flow and client requirements
<b>MATERIAL PREPARATION</b>	By Client or TOMRA	By Client or TOMRA
<b>ASSAYS OF SORTED FRACTIONS</b>	Completed by independent laboratory or by client (optional)	Completed by independent laboratory or by client (required)
<b>LEAD TIME</b>	1-3 weeks subject to test center backlog from receipt of sample	Scheduled upon receipt of samples
<b>WITNESSED</b>	Optional	Strongly recommended - In person or via video conference
<b>OUTCOME / DELIVERABLES</b>	First inspection report detailing preliminary results, recommendations, and image(s) of sorted ore	Detailed technical report based on assay results, sorting quality, process flow, and technology used

TOMRA works with multiple independent assay laboratories to ensure sorted fractions are accurately analyzed. Alternatively, clients may use established in-house methods to evaluate sorted material. This data forms the basis of the testwork report detailing sorting quality, process flow, and the technology used.



Report details technology used: Raw (left) and Classified (right) x-ray sensor image of feed



**SOURCE  
INTO  
RESOURCE**





# SORTER INSTALLATIONS





# LINK TO VIDEO BLUESTONE

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[TOMRA Insight at Bluestone Tin Mine in Tasmania \(youtube.com\)](#)

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# TIN AND NAF/PAF – BLUESTONE RENISON

## PRODUCTION OF NAF/PAF

Acid forming waste back down the mine  
Non-acid forming waste at surface

## CONTROL DEFINED BY WASTE GRADE

High grade feed causing sorter to be run  
with over ejection

## TIN GRADE CONTROL

97% Tin recovery 25% mass reduction

## LOW PH PLANT WATER

Causing premature rusting of sorter

## SORTER DATA

Data from sorter used for process monitoring

## COMPRESSED AIR QUALITY

Oil from compressors causing valve failure



# LINK TO VIDEO QMAG

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<https://youtu.be/RHUANt0dtqU?si=kZ8kOBkK803cXCAC>

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# MAGNESITE SORTING – QMAG

## LONGEST RUNNING SORTERS

Longest running sorters in Australia - 22 years

## REPLACEMENT OF DMS

Sorters remove both sandstone and dolomite from magnesite

## FLEXIBILITY

Sorter programs provide different cut points for products

## VERY LARGE SIZE RANGE

Sorter push beyond name plate

## COMPRESSED AIR

Low pressure causing missed ejections

## SENSOR FAILURES

High humidity caused water ingress in sensors



# LINK TO VIDEO EQ

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[Case study EQ Resources Ltd / Mt. Carbine QLD, Australia \(youtube.com\)](#)

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# TUNGSTEN SORTING – EQ MT CARBINE

## VERY HIGH LEVEL OPERATORS

Best operators reduce maintenance and OPEX

## VERY SIMPLE LAYOUT

Built as needed. Transition to more long term engineering

## LIBERATION

Excellent scheelite / wolframite liberation  
Low mass yield with high recovery

## POWER QUALITY

Voltage drop and spikes causes electronics failures

## ZERO WASTE

EQ sells the sorter waste as aggregate

## END OF LIFE

Some end of life equipment is difficult to service





# THE WORLD'S LARGEST SENSOR-BASED SORTING PLANT

## CAPEX SAVINGS

Significant size decrease comminution & flotation plant (~40% smaller)

## OPEX SAVINGS

>\$10 M p.a. for flotation  
Overall savings ~ \$35 M p.a.

## SORTING CAPACITY

Throughput of up to 1900 t/h



## HIGH CAPEX

\$560 M processing plant at Umm Wu'al

## DUST

Dust extraction a challenge

## MAINTENANCE

Inadequate maintenance causing lower availability

# DIAMONDS PRIMARY CONCENTRATION PLANT



## BIG DIAMONDS

3 out of Top 10  
Sowelo, Le Sedi & Constellation

## LOW OPEX

Bulk concentration from  
€0,11 per ton

## INDUSTRY LEADING PERFORMANCE

>98% recovery for the past 6 years

## HIGH MAINTENANCE

Wet fines causing lower availability

## WATER COOLING

Chilled water manifold causing x-ray tube failures

## SALINE WATER

Causing sorters to rust



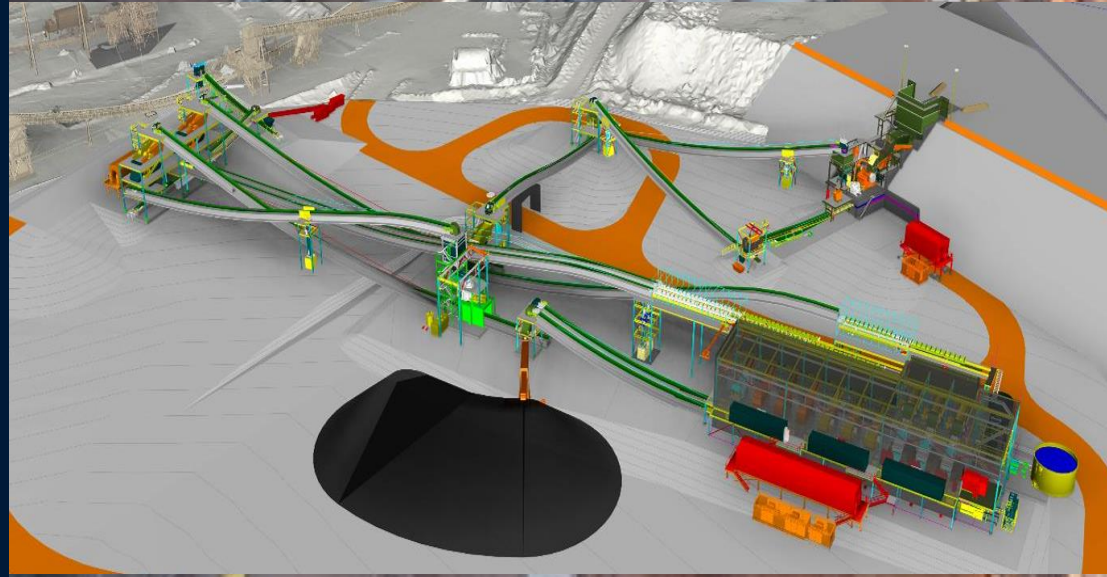
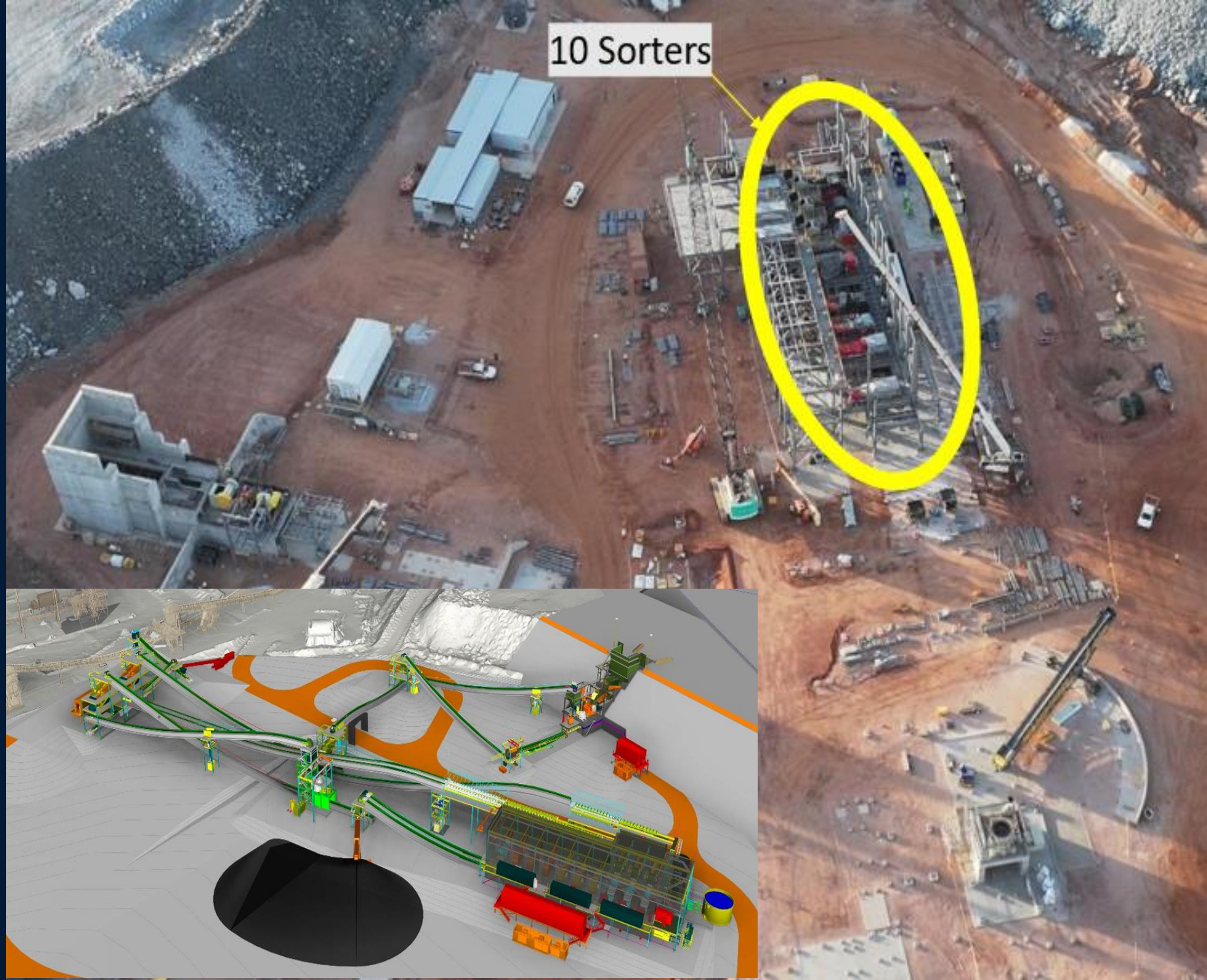


# BIGGEST PLANT IN LITHIUM

Pilbara Minerals  
Commissioning in July  
2024

10 sorters – up to 1000t/h

Basalt removal from  
pegmatite





Rethink. Reimagine. Resource.