



ZENROBOTICS®

Construction and Demolition Waste Sorting Technologies
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OPERATING PRINCIPLES



“New smarter technologies are needed to meet the requirements of tomorrow.”

Intelligent robots will transform the industry

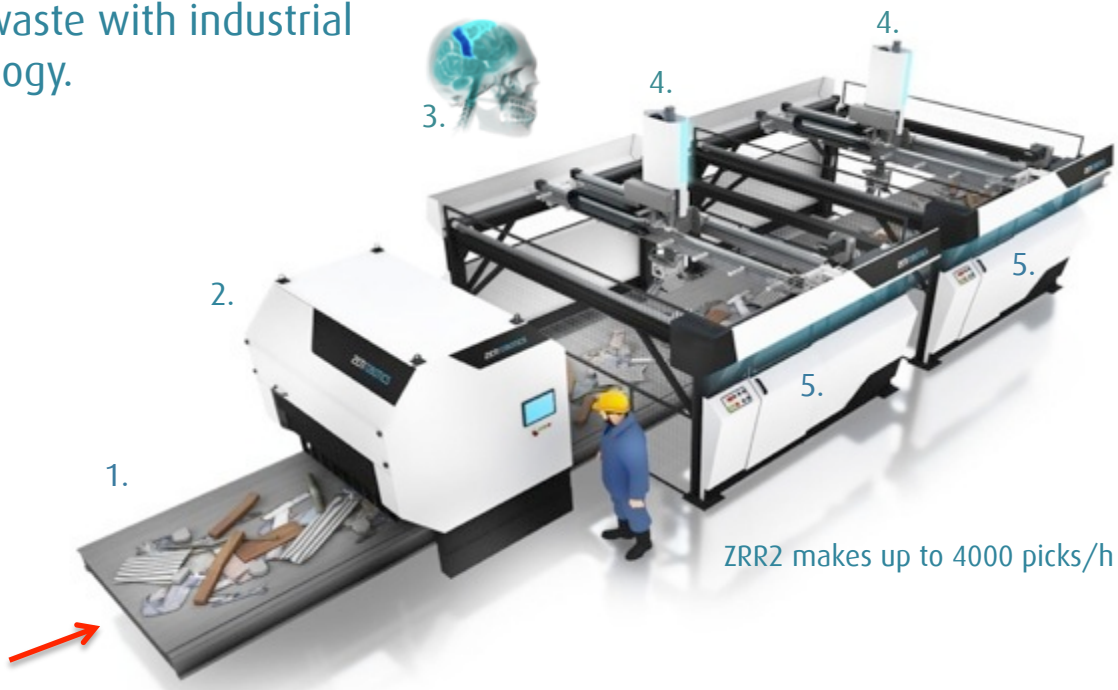


- FLEXIBILITY – Robotic sorting systems are multitasking. They manage several sorting tasks at the same time.
- EFFICIENCY – Robotic systems are designed for 24/7 operation and have very low operating cost.
- HIGH QUALITY – Sorting robots pick fractions with high precision. The ZRR system can be trained to recognise new high-quality end fractions.

ZenRobotics Recycler (ZRR)

ZRR reclaims chosen fractions from waste with industrial robots and machine learning technology.

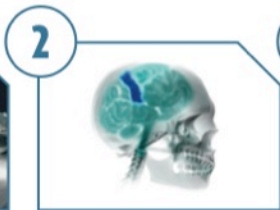
1. **Sorting belt**
robots automatically adjust belt speed
2. **ZRR Sensor Unit**
contains multiple advanced sensors
3. **ZenRobotics Brain Control Software**
in separate climatized control cabinet
4. **Robot arms and Smart Gripper**
up to 4000 picks/h per ZRR2 unit
5. **Drop-off chutes**
up to six chutes per arm



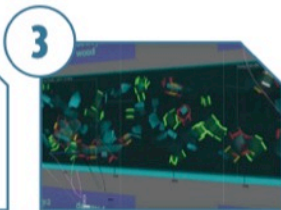
How does it work?



1
ZRR Sensor unit scans the waste stream.



2
ZenRobotics Brain control software analyses data and controls the robots.



3
ZenRobotics Brain identifies materials, objects and gripping points.



4
ZenRobotics Smart Gripper picks the desired objects.



5
Robots sort multiple fractions in one spot.



Sorting multiple fractions simultaneously in one spot



Input: Mixed waste



High quality fractions



What can ZRR sort? For example...

- Mixed wood
- A wood separately
- B wood separately
- Inert mixed
- Inert into sub fractions: concrete, bricks, limestone, asphalt...
- Metals, ferrous & non-ferrous
- Rigid plastics mixed, also black plastic!
- Tubes & pipes by color & shape
- Old corrugated cardboard (OCC)
- Gypsum board
- Plastic bags by color, source separated MSW
- Hybrid sorting: both negative & positive sorting at the same time



Or train new fractions yourself!

Endless opportunities with flexibility



Concrete



Mixed inert



A-wood



B-wood



Metals



Mixed rigid plastics



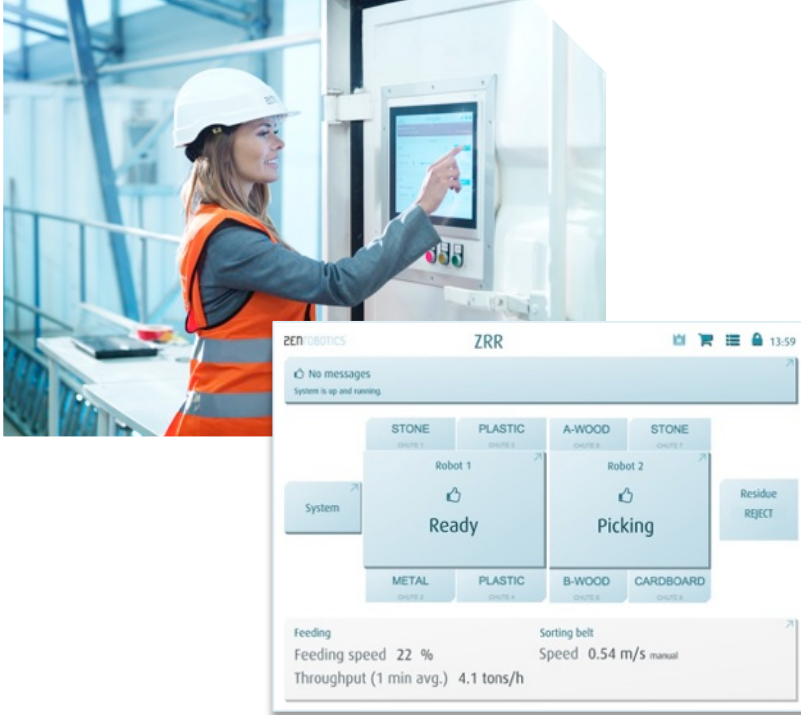
Pipes & tubes



Plastic bags by color

Or train ZRR to pick new fractions yourself!

Change the sorting task on the go!



- Easy-to-use User Interface (UI)
- Flexible operation: Operator can easily change the sorting task and choose desired objects to sort out
- Multitasking system: Sorting multiple fractions in one spot
- Unique flexibility in waste sorting – Allows the operator to quickly react to changes in the waste stream

Train your own ZRR



ZRR is easily trained to

- introduce a new fraction for sorting
- improve sorting quality, or
- divide fractions into new sub-fractions

Customer quote: “Working with ZRR allows us to respond quickly to changes in the quantities and properties of the input material. [...] We are able to train the robots to learn and handle different types of materials which makes the system useful and profitable for us.”

Monitor and control your robots

- Easy access to site-specific performance data
- Online analysis of the waste stream and sorting results
- Key information for controlling and optimizing your production
- Easily accessed online anywhere in the world on your PC, tablet or smartphone



Performance data reporting tool

ZenRobotics Recycler is powerful and fast

	ZRR1	ZRR2	Semi-Mobile
Robot arms:	one	two	two
Max. picking speed (with 5 kg objects)	2.000	4.000	4.000
Picking area / robot (length/width)	2m/1,6m	2m/1,6m	2m/1,6m
Max. object weight:	20 kg	20 kg	20 kg
Max. object size (length/width)	1,5 m/ 0,5 m	1,5 m/ 0,5 m	1,5 m/ 0,5m
ZRR Length (incl. safety cage)	6,0 m	9,5 m	14 m
Power consumption	10 kW	14 kW	16 kW



ZRR performance

Hourly performance:

Average object weight x picking speed
= tons sorted

For example:

0,7 kg x 4000 picks/h = 2.8 tons/h

2,0 kg x 4000 picks/h = 8 tons/h

4,0 kg x 4000 picks/h = 16 tons/h

Multiplied by operating hours per year

There are 8760 hours in a year!



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PROCESS

Feeding

- Singularized monolayer
 - Robots, can pick from piles, but
 - Singularized monolayer = efficiency:
one scanner, multiple robots

Typical process



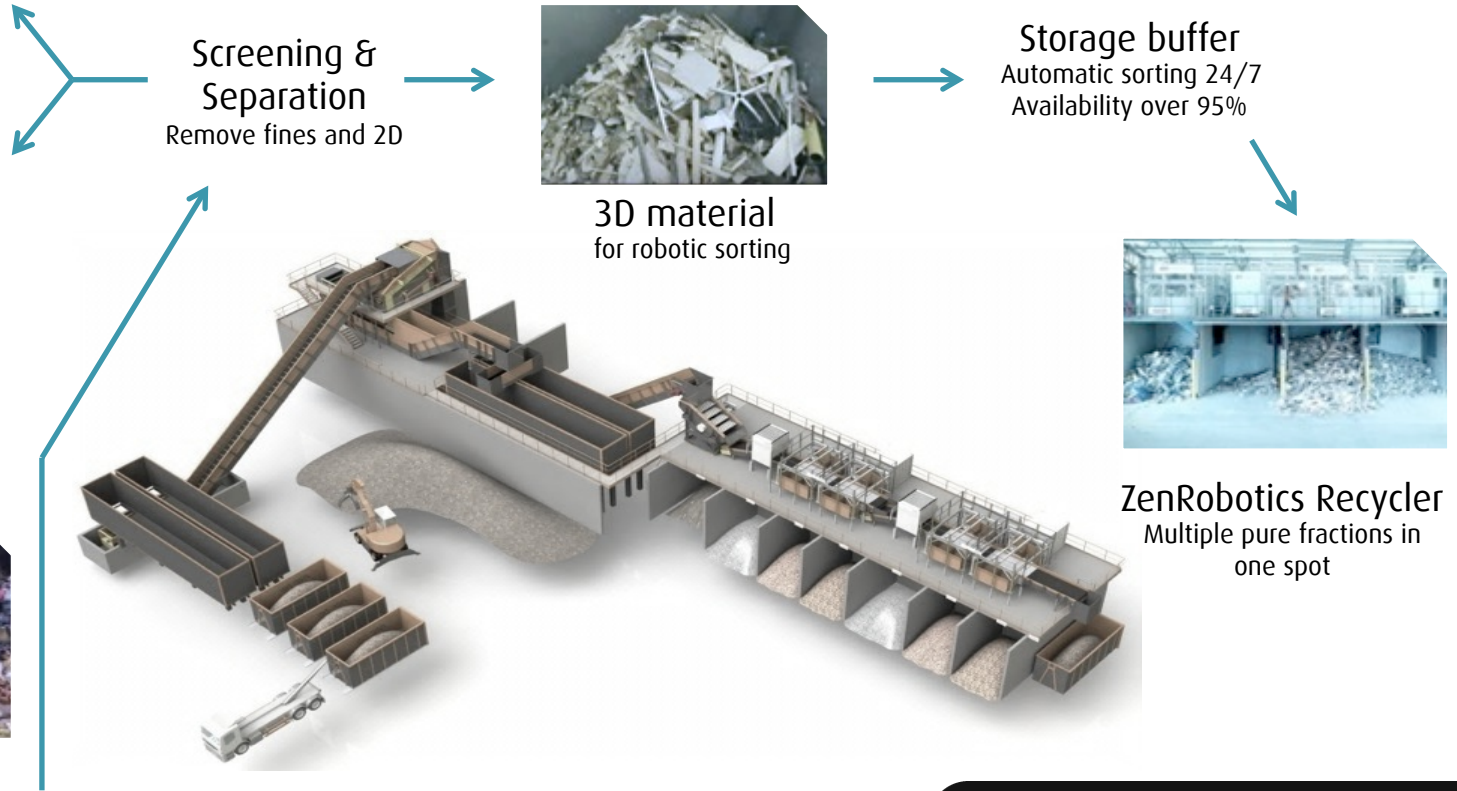
Fines < 100mm
To mechanical treatment



2D material
To RDF or material recovery



Input: Mixed Waste



Screening &
Separation
Remove fines and 2D



3D material
for robotic sorting

Storage buffer
Automatic sorting 24/7
Availability over 95%



ZenRobotics Recycler
Multiple pure fractions in
one spot

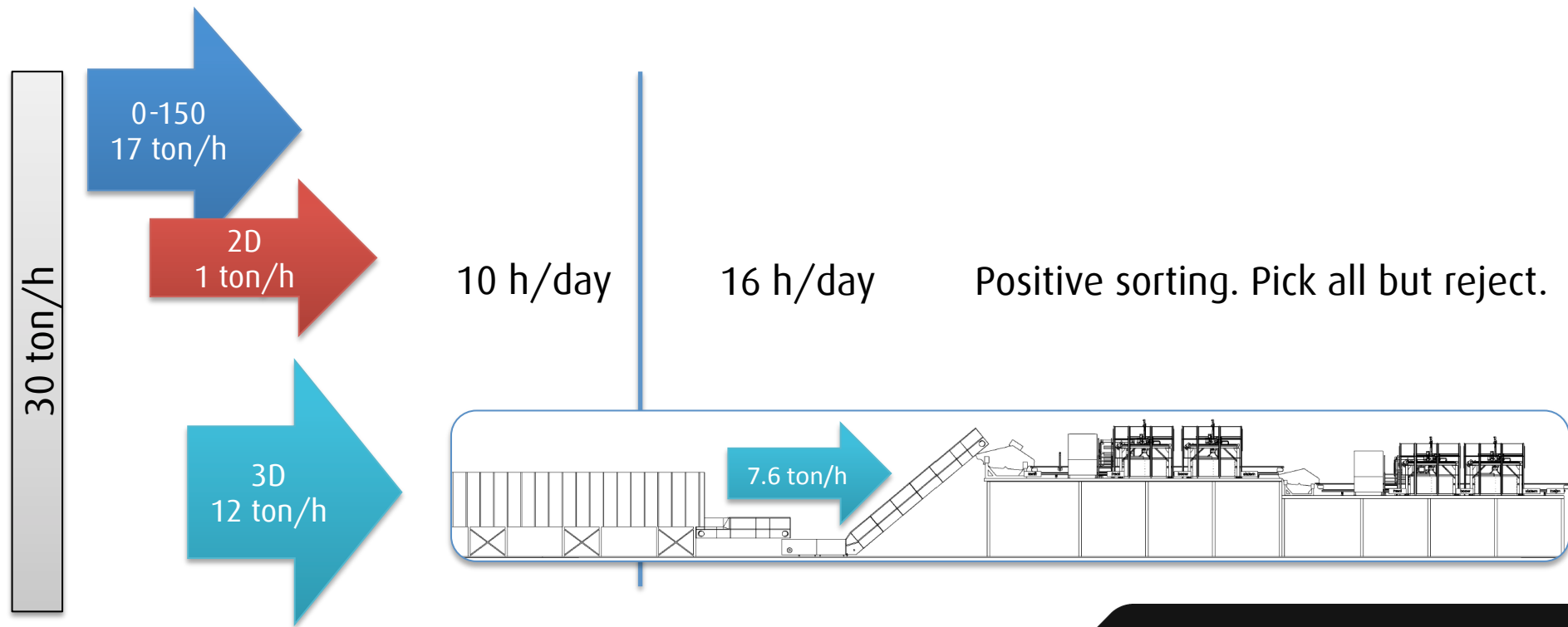
VERY LOW operating cost!

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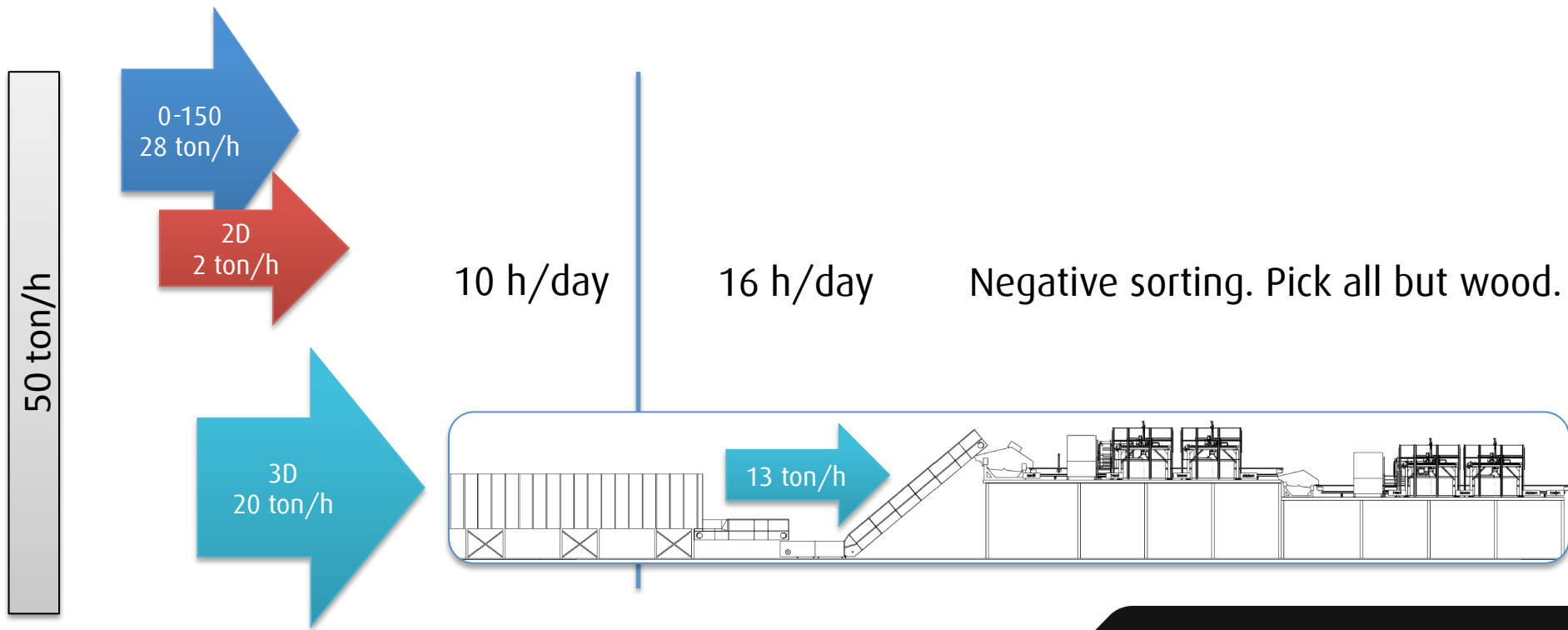


Example material Flow
UK, heavy material, mineral fractions dominate

Buffering – positive sorting



Buffering – negative sorting



Total plant throughput (tons / year)

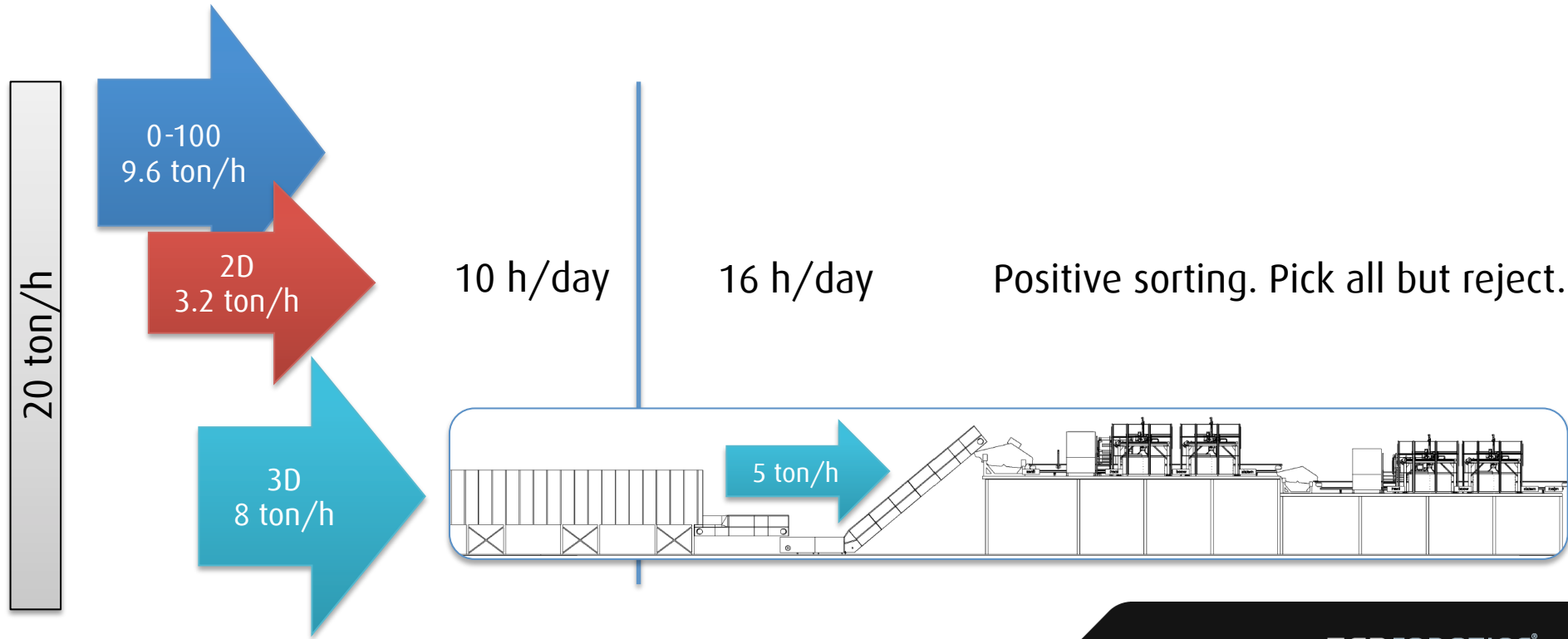
- with only one ZenRobotics sorting line

ZRR operating hours per year	Positive sorting	Negative sorting
1 shift, 2000 hours	38 000	65 000
2 shifts, 4000 hours	76 000	131 000
3 shifts, 6000 hours	115 000	197 000



Example material Flow
Scandinavia, light material, wood fractions dominate

Buffering – positive sorting



Total plant throughput (tons / year)

- with only one ZenRobotics sorting line

ZRR operating hours per year	Positive sorting
1 shift, 2000 hours	26 000
2 shifts, 4000 hours	52 000
3 shifts, 6000 hours	78 000

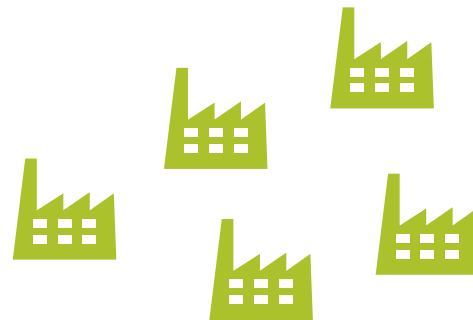
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Paradigm Shift



LARGE PLANT
@ LOW OPERATING COST

BUT NOW
ALSO



NETWORK OF
SMALL PLANTS
@ LOW OPERATING COST



References

ZenRobotics Customers



ZenRobotics customers



FINLAND – SUEZ

NETHERLANDS – Baetsen

SWITZERLAND - Eberhard

JAPAN - Shitara Group

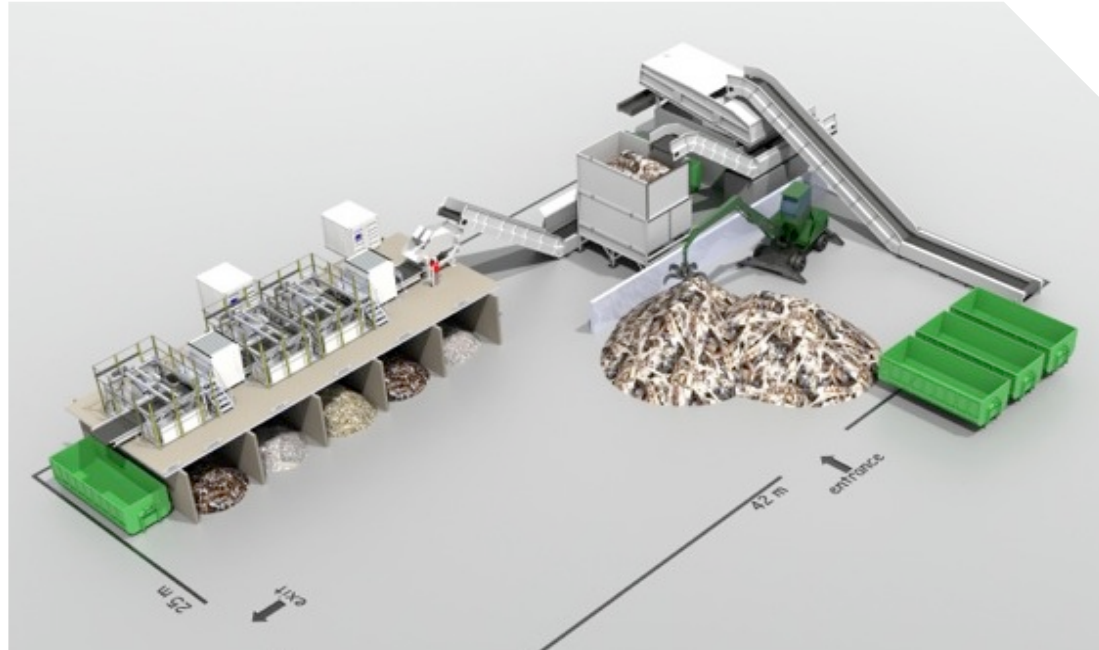
FRANCE - Veolia

USA - ML Environmental

SWEDEN – To be announced

AUSTRALIA – To be announced

World's first robotic sorting station



SUEZ, Helsinki

- Unmanned robotic sorting station
- Possibility to run 24/7
- Efficient waste sorting
- Low operating cost

SUEZ environnement, Helsinki (Finland)



*The most
energy-
efficient
sorting station
in the world*

- Plant capacity: 15-20 tons / hour
- Plant area: 42m x 25m
- Plant power consumption: 60-80 kW
- Three robot arms (1 ZRR2 & 1 ZRR1)
- Robot line capacity: 5 tons / hour
- Sorting task: C&D (metals, wood, stone, rigid plastics)

Eberhard, Zurich (Switzerland)

- Robot line power consumption: 15 kW
- Two robot arms (1 ZRR2)
- Robot line capacity: 10 tons/h
- Pure final products from mineral stream
- Sorting task: Separating minerals by type: concrete, bricks, gasbeton, etc.

Converting
mono-stream
to clean end
products

Baetsen, Son (The Netherlands)

- State-of-the-art plant
- Plant capacity: 150 000 tons / year
- Two robot arms (2 x ZRR1)
- Sorting task: wood, inert, metals

Works side-by-side with manual sorters to increase efficiency

Next steps for robotic happiness?

1. Call sales hotline: +358 50 4363 803 or
E-mail: sales@zenrobotics.com
2. See the robots LIVE at one of our reference
sites
3. Let's discuss how your operations could
benefit from robotic waste sorting

For more information, visit www.zenrobotics.com

And check out our videos on YouTube

<https://www.youtube.com/watch?v=dUQvdl4QZT0>

<https://www.youtube.com/watch?v=z1gO6Qsb6tQ>

