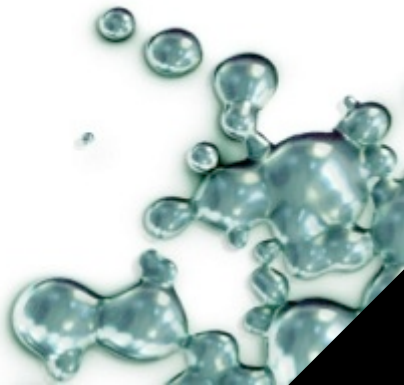
ZENROBOTICS®

- The Green Future of Robotics -

ZenRobotics Recycler

World's first robotic waste sorting system



Why are cars made by robots?
Mass manufacturing = Affordable

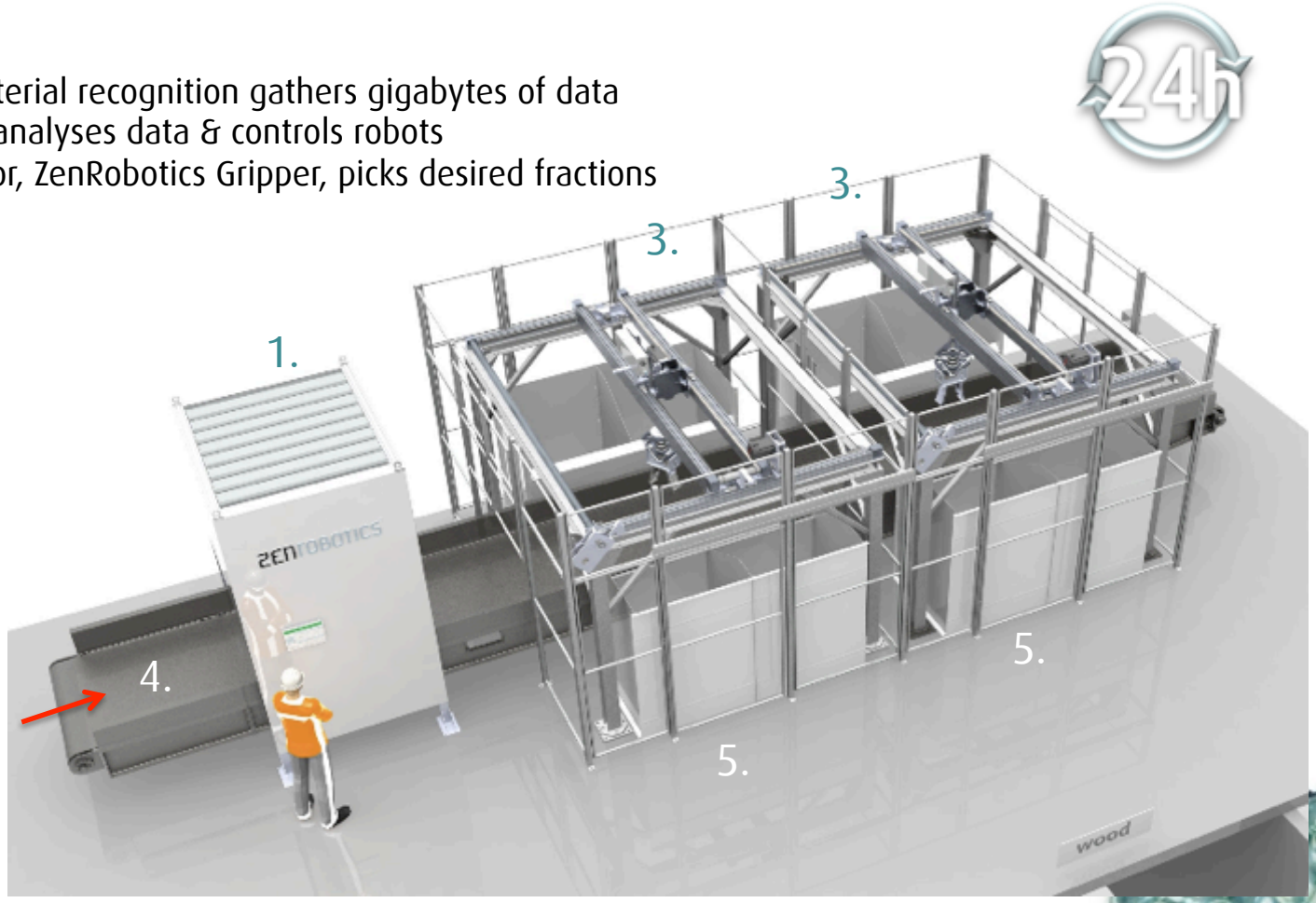
Then and now...

The Product: ZenRobotics Recycler™

Enabled by ZenRobotics Brain™

1. Sensor unit for material recognition gathers gigabytes of data
2. ZenRobotics Brain analyses data & controls robots
3. Robotic manipulator, ZenRobotics Gripper, picks desired fractions
4. Sorting belt
5. Drop-off chutes

Customer earns from selling raw materials, savings in disposal fees and labor costs.



ZenRobotics Recycler: Technical Features

Common features for all models:

- Max object weight: 20kg
- Max object size: L 1,5 m, W 0,5 m
- Operating area per arm: 2m x 2m

Model ZRR2

- Max picking speed: 4 000 picks/h
- Length of system: 9,5 m (including safety cage)
- Power consumption: 14kW

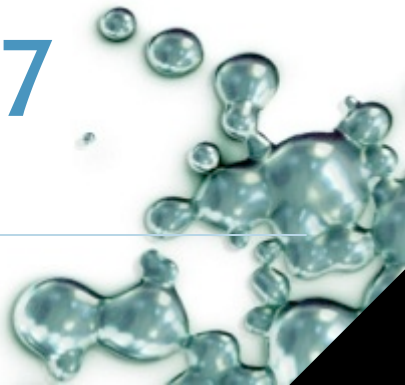
Model ZRR1

- Max picking speed: 2 000 picks/h
- Length of system: 6 m (including safety cage)
- Power consumption: 10kW

Best Available Technology

- Learning system: Gets better over time
  - Customers can download new fractions and features as upgrades
- Easy operation: Switch the sorting task on the go
  - Easy User Interface, touch screen & mobile devices
- Multitasking system: Many fractions on one spot
  - Unique flexibility in waste sorting
- Very high durability: Hardware specifically designed for heavy waste processing environments
  - Requires minimum maintenance
- Small environmental impact: Low energy consumption, low noise, low dust, no sludge, minimal risk of fire, small footprint etc.

ROBOTIC SORTING STATION – SIMPLE, FLEXIBLE PROCESS 24/7



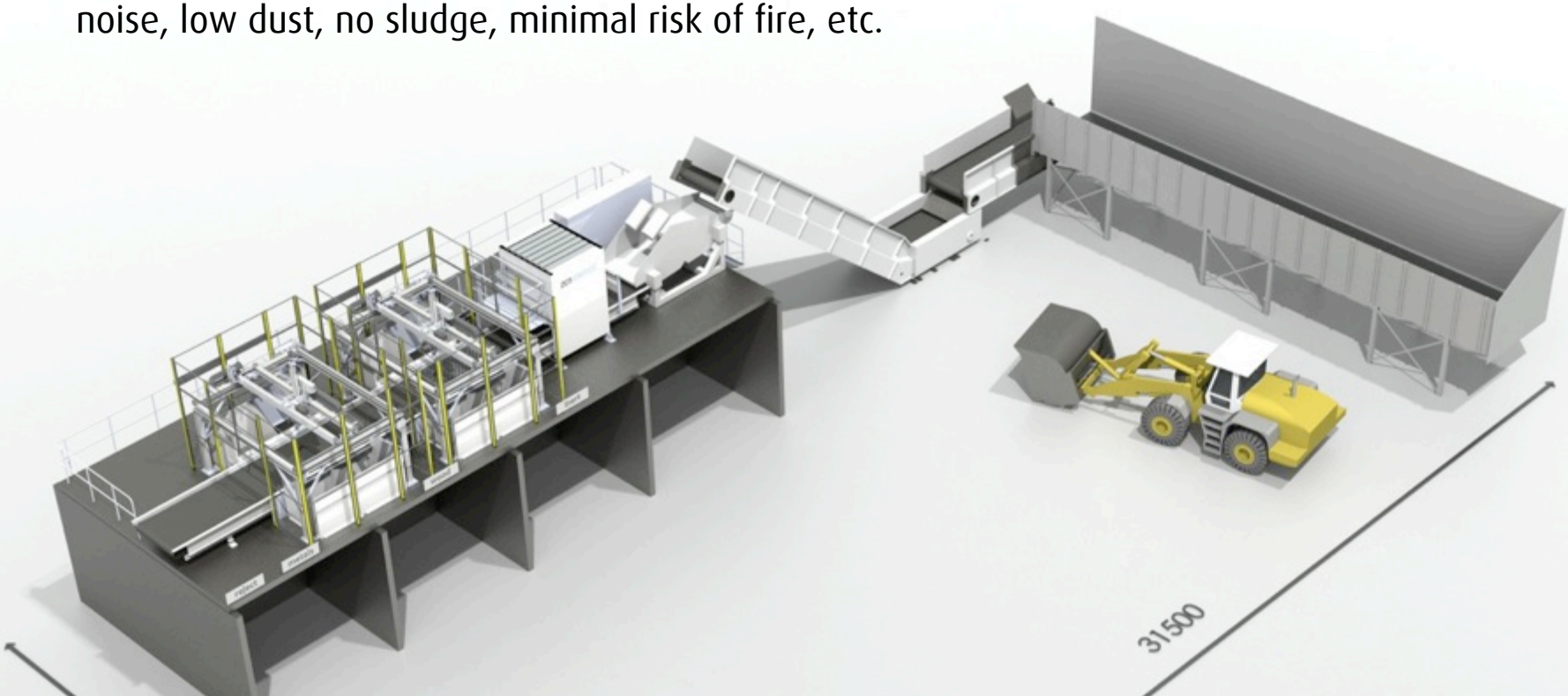
24/7 operation for cost efficiency

- Flexible and simple material recovery from C&D and C&I waste streams
- Low operating cost
- Performance:
  - Average object weight x average picking speed = tons sorted

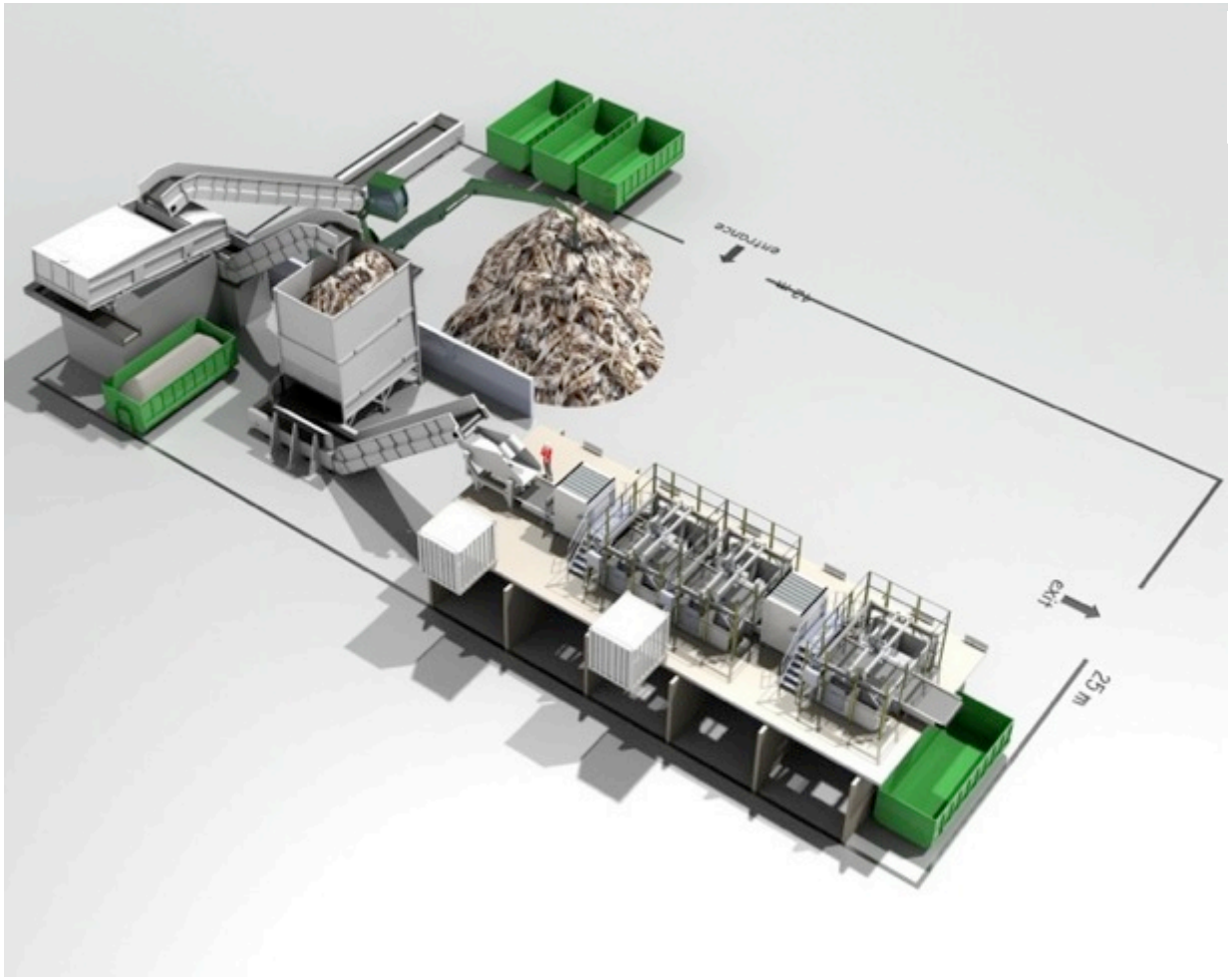
  For example:
  - 0,7 kg x 3000 p/h = 2 tons/h
  - 2,0 kg x 3000 p/h = 6 tons/h
  - 4,0 kg x 3000 p/h = 12 tons/h
- Multiply that by net operating hours per year!
- There is 8760 hours in a year!

Robotic Sorting Station: Simple Process

- Decentralized sorting stations possible, huge savings in logistics
- Sort large range of object sizes without complex preprocessing
- Expensive crushing and fine fraction generation is avoided
- Small environmental impact, i.e. low energy consumption, low noise, low dust, no sludge, minimal risk of fire, etc.



World's First Robotic Sorting Station: SUEZ Environnement, Helsinki



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ZENROBOTICS

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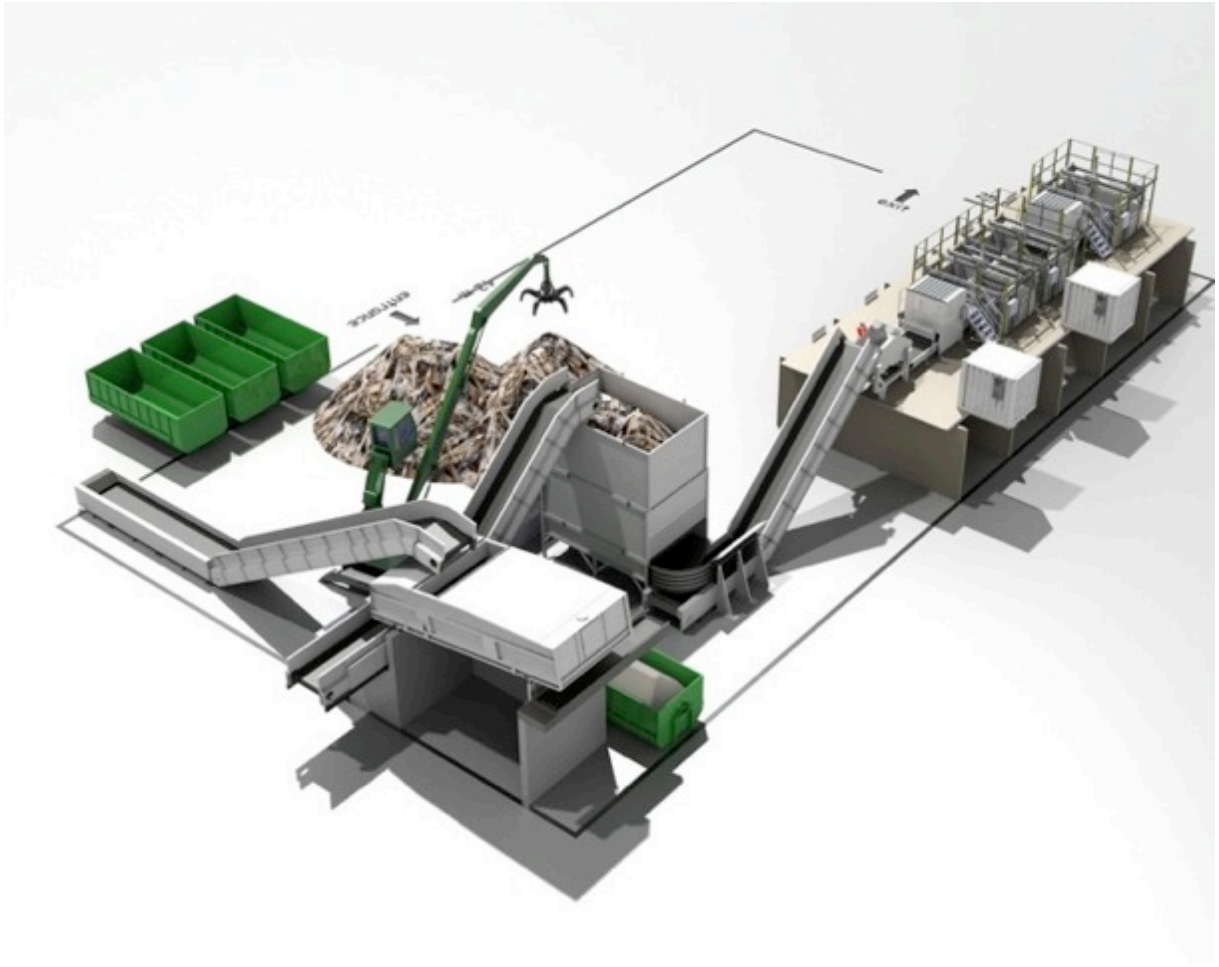


Robotic Sorting Station: Throughput

- As much as you can feed - but maintaining singularized monolayer
- Max belt speed 0,5 m/s, max belt width 1,6 m
- Max throughput in tons/h depends on density of material!

Robotic Sorting Station: Operation

Alternative Operation Modes:

1. Maximize throughput → run belt fast, or

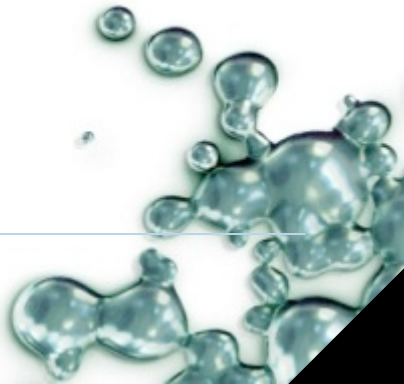
2. Minimize reject → run belt slow, or

3. Switch to Automatic Belt Speed control and Automatic Virtual €-Screening - and let the ZRR choose the most profitable mode!

Waste Stream and Feeding Requirements

- Processed waste: Construction & Demolition (C&D) and Commercial & Industrial (C&I) waste
- Pretreatment:
    a) Remove fines (<80 - 150 mm)
    b) Remove over sized materials (>1 – 1,5 m)
    c) Remove 2D materials (such as foils, paper, cardboard, foams and carpets)
- Distribution on sorting belt: Mainly singularized mono layer (>30 mm free space between objects)

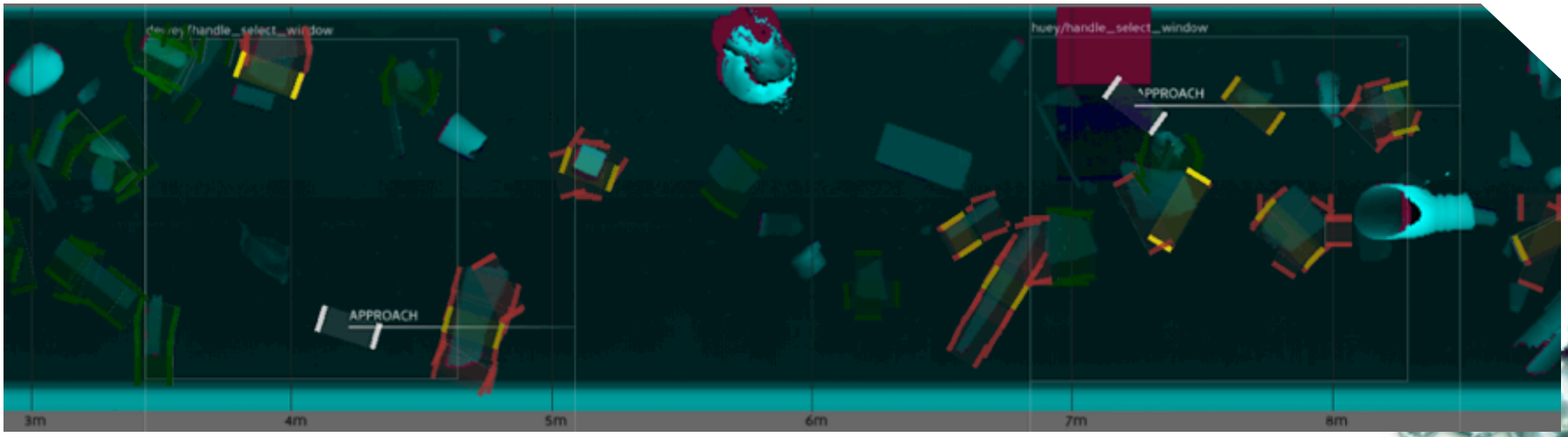
HIGH QUALITY FRACTIONS = INCREASED PROFITS



Making Sense from Waste

High Purity & Reporting of Waste Composition

- Sensor Fusion enables accurate analysis of the waste
- High purity - up to 95 %, adjustable by the operator
- Easy User Interface
- Advanced self diagnostics, remote monitoring and support over the Internet
- Online analysis of the waste stream creates valuable statistics including
  - Waste composition
  - Tonnage
  - Value



Available fractions

- Metals (Ferrous & Non-Ferrous)
- Wood
  - A & B wood mixed
  - Class A wood separately
  - Class B wood separately
- Rigid plastics
  - Rigid plastics mixed
  - Tubes & pipes by color
- Inert
  - Inert mixed
  - Inert sub fractions: concrete, bricks, limestone, asphalt…
- Old corrugated cardboard (OCC)
- Sorting plastic bags by color
- Negative sorting (under development)

What do you want to have next?

Quality fractions: Metals sorted by ZRR

(If magnet would be installed, this would be very pure non ferrous)

Quality fractions: Inert sorted by ZRR

(Red bricks and light concrete can be sorted separately)

Quality fractions: Wood sorted by ZRR

(A wood is here sorted separately)

Quality fractions: Rigid plastics sorted by ZRR

(In future upgrade versions plastics can be sorted by color and polymer)

Quality fractions: Tubes & pipes sorted by ZRR

(Also sorting pipes & tubes by color)

Other sorting tasks: ZRR sorting plastic bags by color

ZenRobotics Customers

- SUEZ Environnement Finland
  - Based in Helsinki, Finland
  - Delivered 3 units: first pilot unit in 2012,
    Additional Next Generation ZenRobotics Recycler units in 2014
  - ZenRobotics and SUEZ Environnement have signed
    a global frame agreement for delivering ZRR units globally
- Baetsen Recycling
  - Based in Eindhoven, The Netherlands
  - Delivered one 2-robot unit in March 2013
- Eberhard
  - Based in Zurich, Switzerland
  - Delivered one 2-robot unit in August 2015
- Shitara Group
  - Japan
  - Delivery of one 2-robot unit in 2016

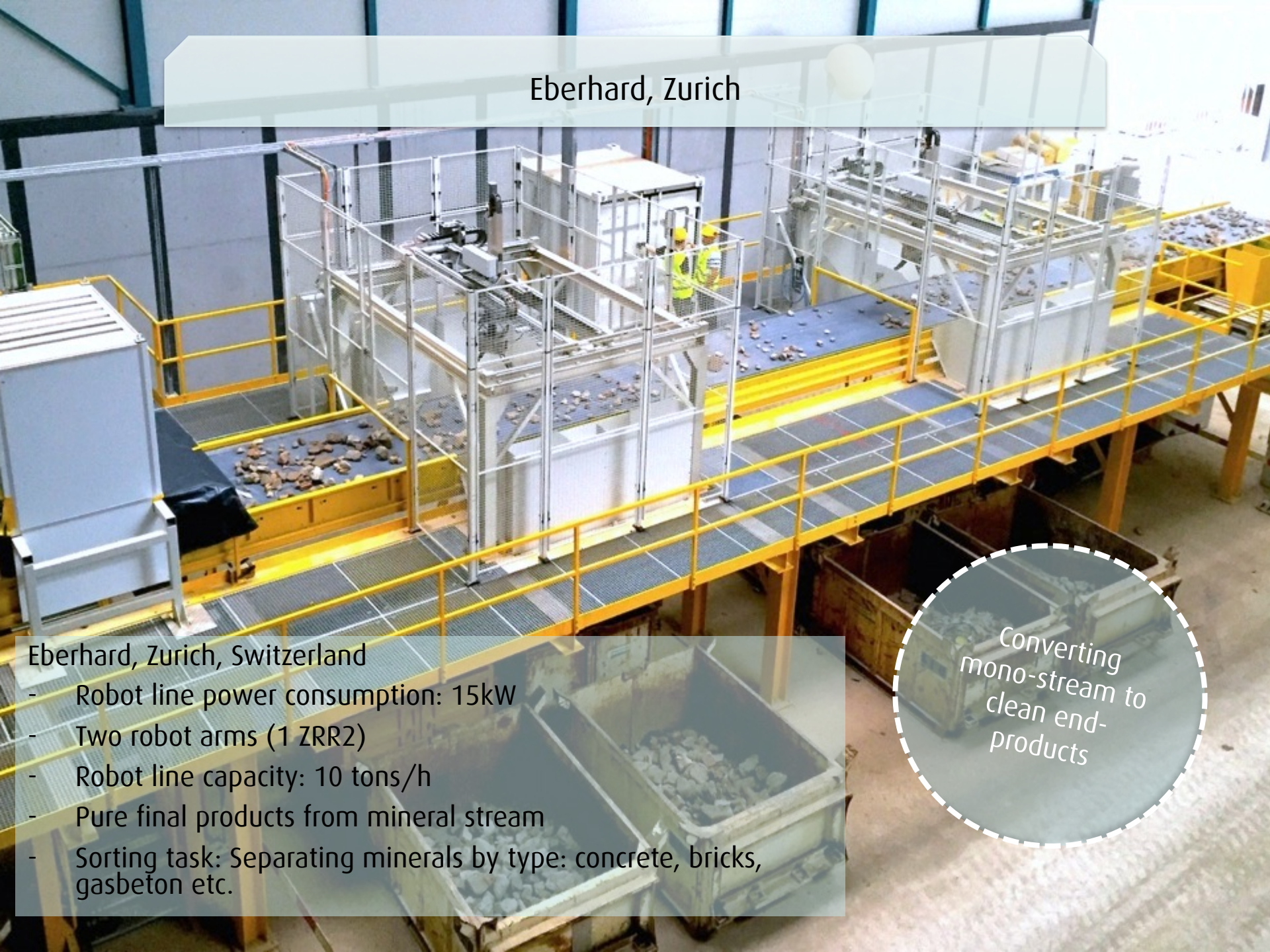
SUEZ environnement, Helsinki

The most energy-efficient sorting station in the world

SUEZ Environnement Finland – Robotic Sorting Station

- 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

Eberhard, Zurich



Eberhard, Zurich, Switzerland

- Robot line power consumption: 15kW
- 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

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

ZenRobotics Ltd. in Brief

- Founded in 2007
- ZRR product development 2009
  - Robotic waste sorting system
  - Artificial intelligence based control system is unique
- 30 employees
- Current status
  - ZRR units delivered to customers in Finland, the Netherlands, Switzerland
  - Several units to be delivered in Japan 2016
  - Wide distributor network covering key markets
- Ownership: Privately held company owned by management, employees, and long-term private equity investors
  - Invus, Veraventure, Lifeline Ventures

Thank you!

www.zenrobotics.com