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Massimo Serapioni
General Manager Business Unit Recycling I Coperion

Recycling Days
Day 2

Chris Dow
Chris Dow I Business Development Manager, Business Unit Recycling I Coperion

AGENDA | NOV 07, 2024

09:00	**Welcome** Massimo Serapioni I General Manager Business Unit Recycling I Coperion
09:10	**Plastics in Circular Economy - Requirements and Challenges** Prof. Daniel Schwendemann I Institute for Material Science and Plastics Processing (IWK) OST University of Applied Sciences Eastern Switzerland
09:40	**State of the Art Solutions for Material Handling, Deodorization and Degassing** Francesco Arvieri I Sales Manager I Coperion
10:25	Coffee break
10:45	**Application Deep Dive: Highest Quality in Flexible Film Recycling with Coperion Recycling Technology** Marina Matta I Team Leader Process Technology Recycling I Coperion Olivier Logeat I Directeur Operations Plastiques I SUEZ RV France SA

AGENDA | NOV 07, 2024

11:30	**Application Deep Dive: Twin Screw Extrusion and Polymetrix SSP Decontamination Technology for rPET** Sabine Schönfeld I Sales Manager I Coperion Martin Müller I CEO I Polymetrix Devendra Surana | Founder & Managing Director | Magpet Polymers private Ltd.
12:15	Lunch
13:15	**Plant Tour & Live Demonstration: Recycling Innovation Center**
14:15	Coffee break
14:25	**Full-Scale Turnkey Systems for the Recycling Industry** Miguel Teran I Sales Engineer Compounding Plants I Coperion
14:40	**Professional Customer Service** Georg Vögele I Key Account Manager Aftersales - Recycling Systems I Coperion

AGENDA | NOV 07, 2024

14:55	**C-Beyond 4.0: How to Boost Productivity and Efficiency with Digital Solutions** Markus Schmudde I Head of Research & Development Compounding & Extrusion I Coperion Tanja Karrer I Electrical Engineer Control Systems I Coperion
15:10	**Final presentation & closing remarks** Chris Dow I Business Development Manager, Business Unit Recycling I Coperion Massimo Serapioni I General Manager Business Unit Recycling I Coperion
15:30	End of conference


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Plastics in Circular Economy - Requirements and Challenges

Prof. Daniel Schwendemann
Institute for Material Science and Plastics Processing (IWK)
OST University of Applied Sciences Eastern Switzerland

OST
Ostschweizer
Fachhochschule

Plastics in circular economy - requirements and challenges

Coperion Recycling Days, Weingarten Germany

Prof. Daniel Schwendemann

Coperion Recycling Days, 7th of November 2024

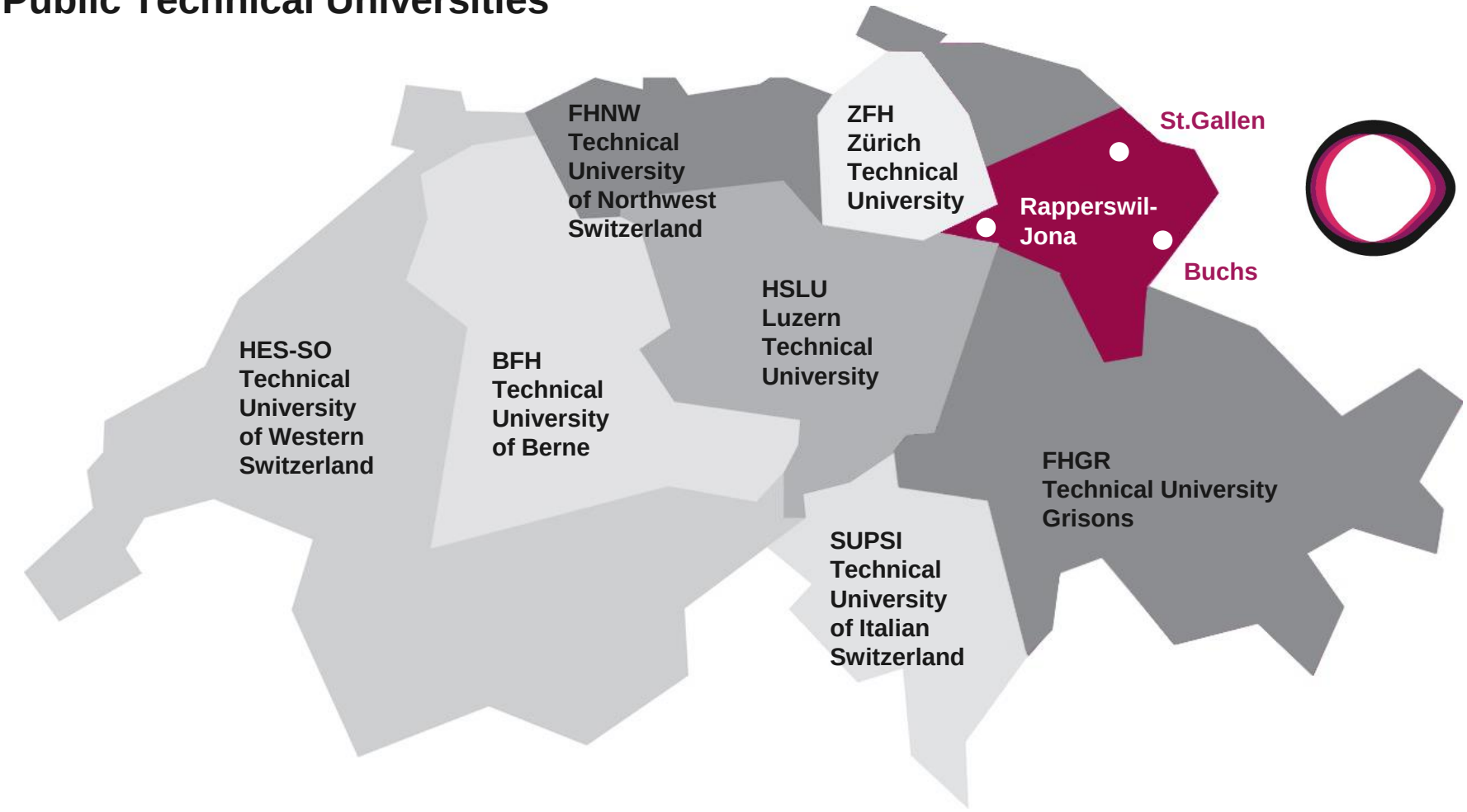
iwk INSTITUTE FOR MATERIALS TECHNOLOGY AND PLASTICS PROCESSING

Overview

1. OST – Eastern Switzerland University of Applied Sciences / IWK
2. Motivation
3. Circular economy
4. Recycling challenges
5. Project examples

Technical Universities in Switzerland

Eight Public Technical Universities



Competences at IWK

Plastics Processing

Prof. Daniel Schwendemann
Dep. Head of the Institute

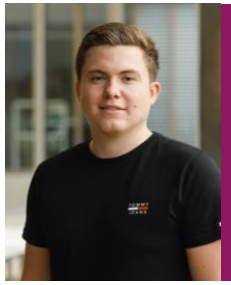
Department Compounding / Extrusion

Prof. Dr. Gion A. Barandun

Department Composite fibre technology / Lightweight construction

Daniel Omidvarkajan

Department 3D-printing / Additive Manufacturing



Japer Hollender

Department Injection moulding / PUR

Metal Manufacturing

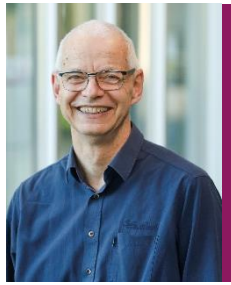
Prof. Dr. Mohammad Rabiey

Department Manufacturing Technology - Metals

Interdisciplinary Topics

Prof. Dr. Markus Henne

Department Mechanical Systems



Prof. Dr. Samuel Affolter

Department Materials analysis / Component testing

Prof. Dr. Mario Studer

Department Computational Engineering

Prof. Dr. Pierre Jousset

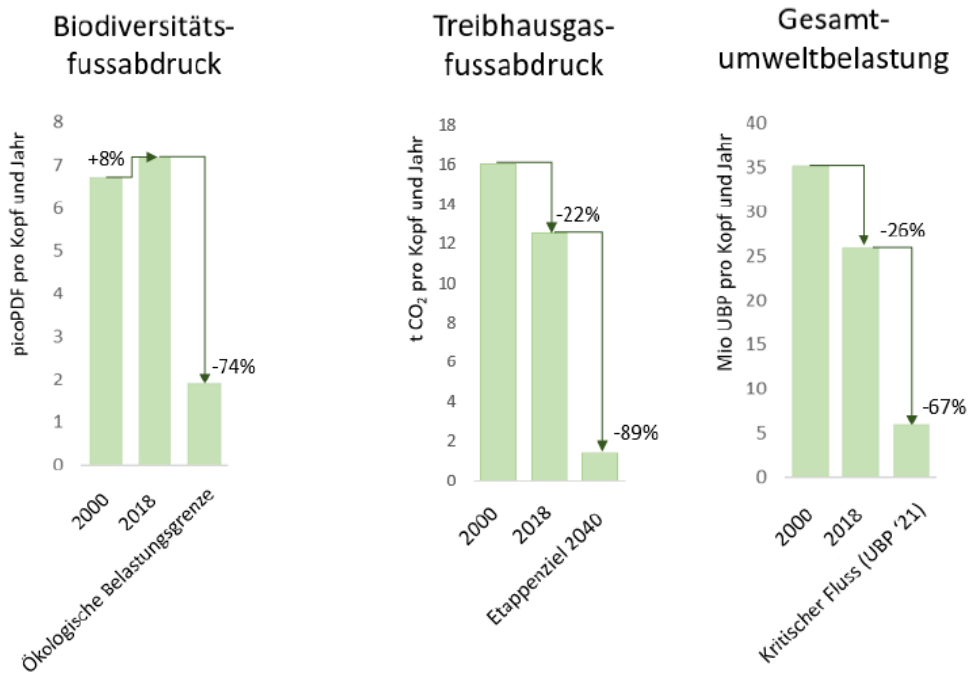
Department Connection technology

Institute Management

Prof. Dr.-Ing. Frank Ehrig
Head of the Institute

Circular economy

The footprint of Switzerland exceeds ecological limits

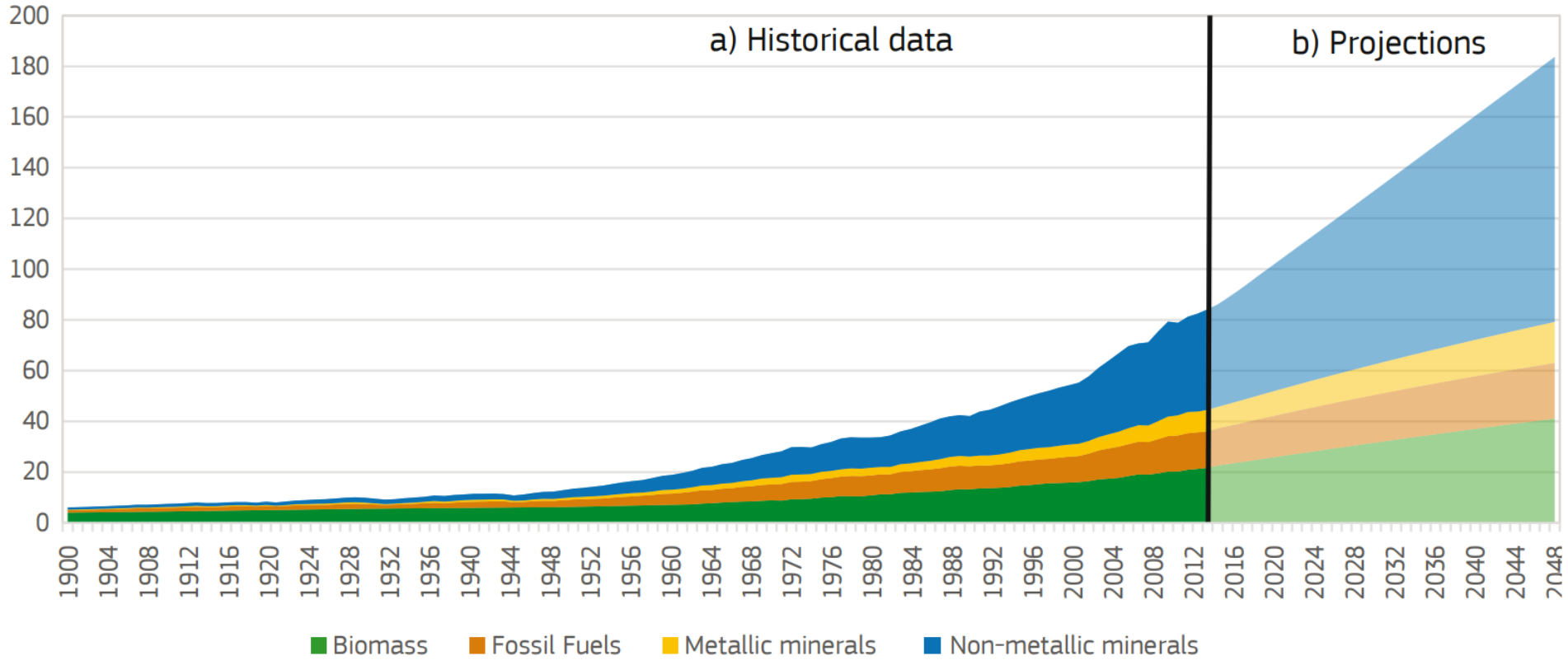


estimated reduction needs
(EBP 2022)

- **Over 60 %** of the total environmental impact in 3 consummation sectors: **living** (25 %), **nutrion** (25%), **mobility** (14%)
- **Share in foreign countries** of the swiss consumation environmental impact: **68 %**

source: EBP (2022): Umwelt-Fussabdrücke der Schweiz

Why circular economy?

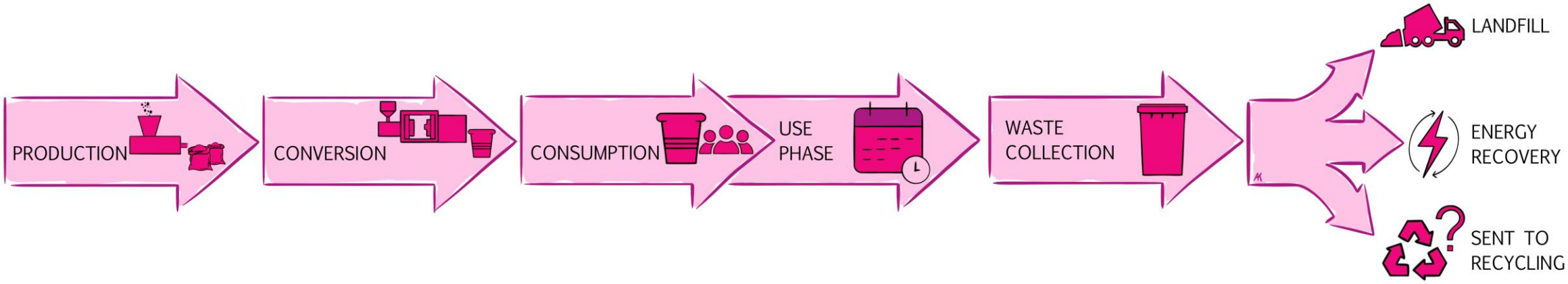


© EC JRC Raw materials scoreboard 2018

© European Plastics Facts

Current situation - Problem!

Flow of the material from the production to the end-of-life



Picture: IWK

What do we do with the recyclate?

Development line – " flow of thinking and acting "

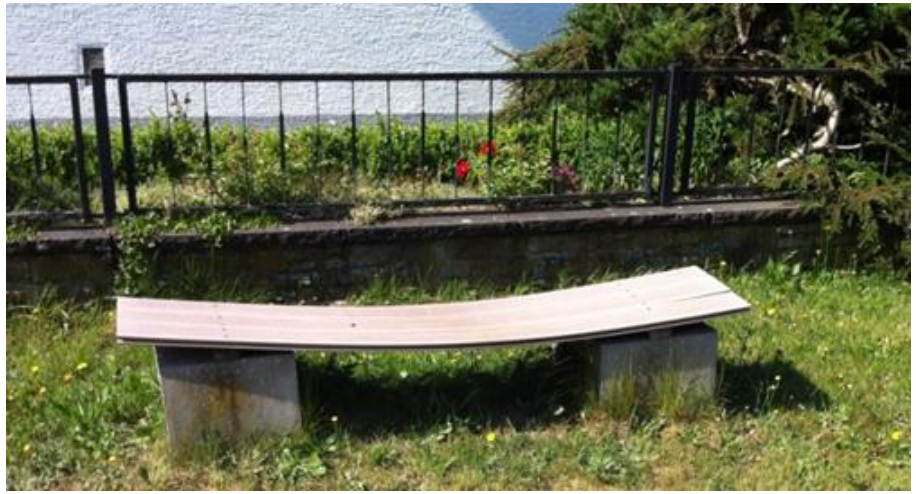
Current situation - Problem!

The problem arises from the way in which planning is carried out in development

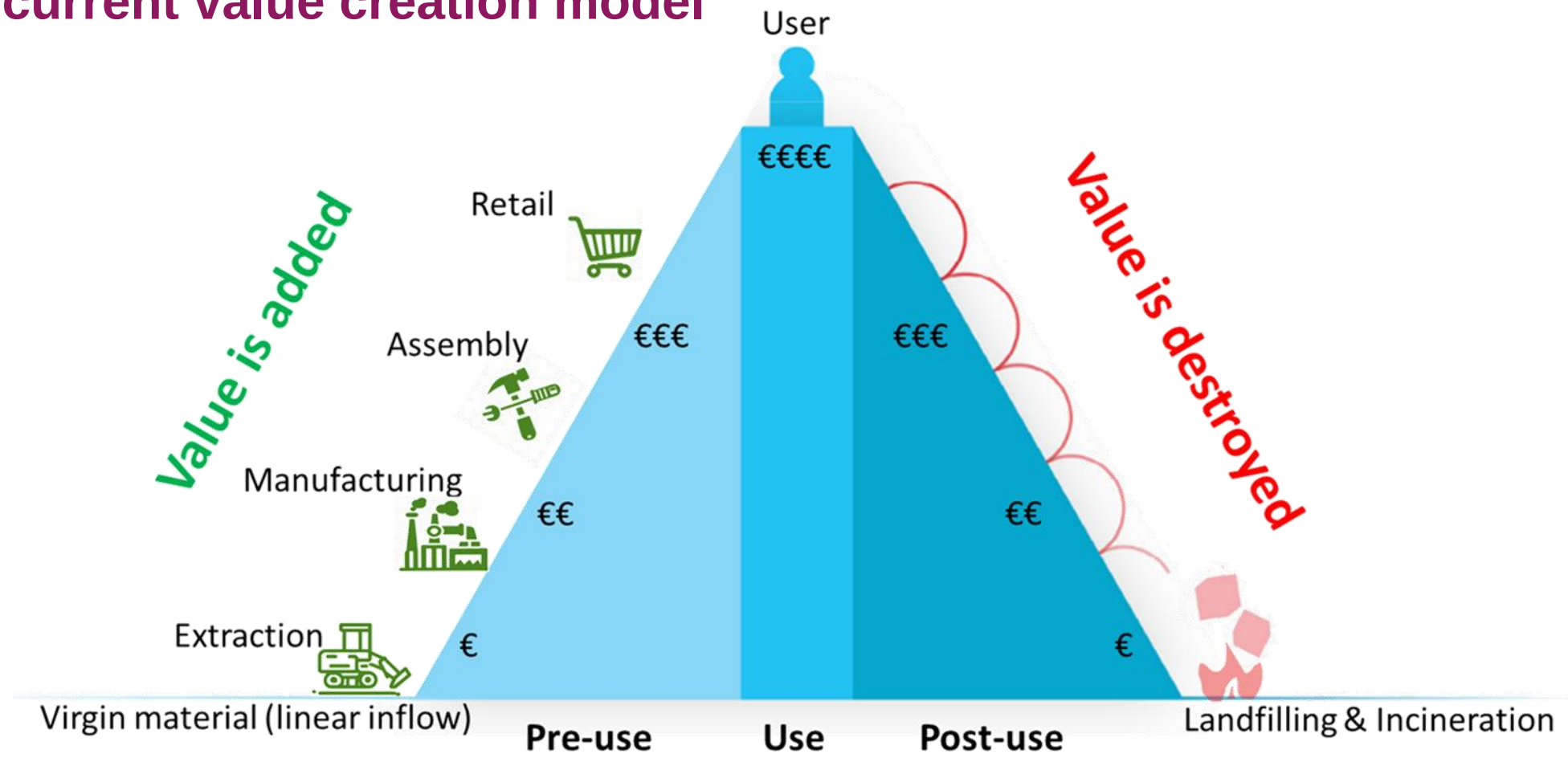
Plastic waste is collected and then someone/somewhere is supposed to take over the sorting and processing.

After that, a possible area of application is sought

 The result is "down-cycling" with poor material properties, which also leads to a negative image of plastic as a material.



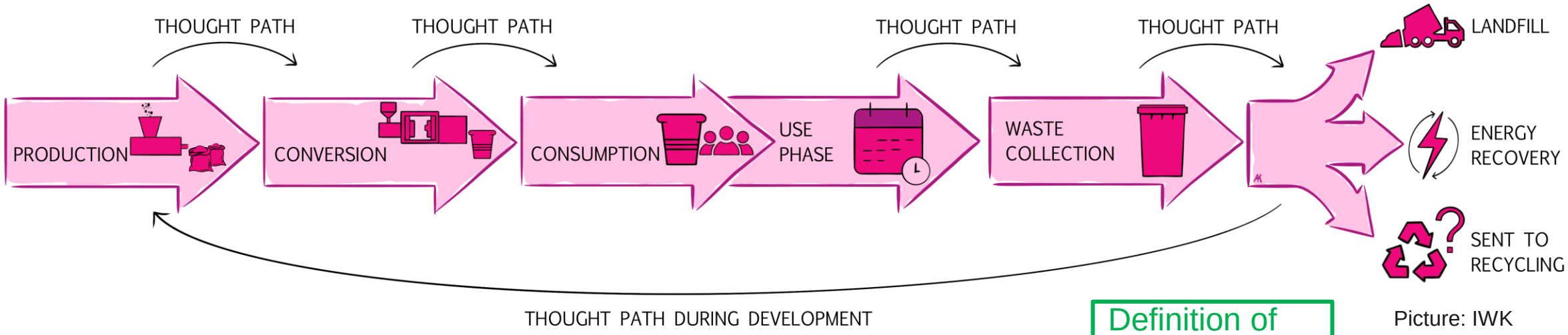
Our current value creation model



Quelle: Nicolas Hofer et al. in Podleisek/Hänggi/Luban 2023 (unpublished) based on Achterberg/Hinfelaar/Bocken (2016)

The solution is a new approach of thinking

Identify the potential application areas



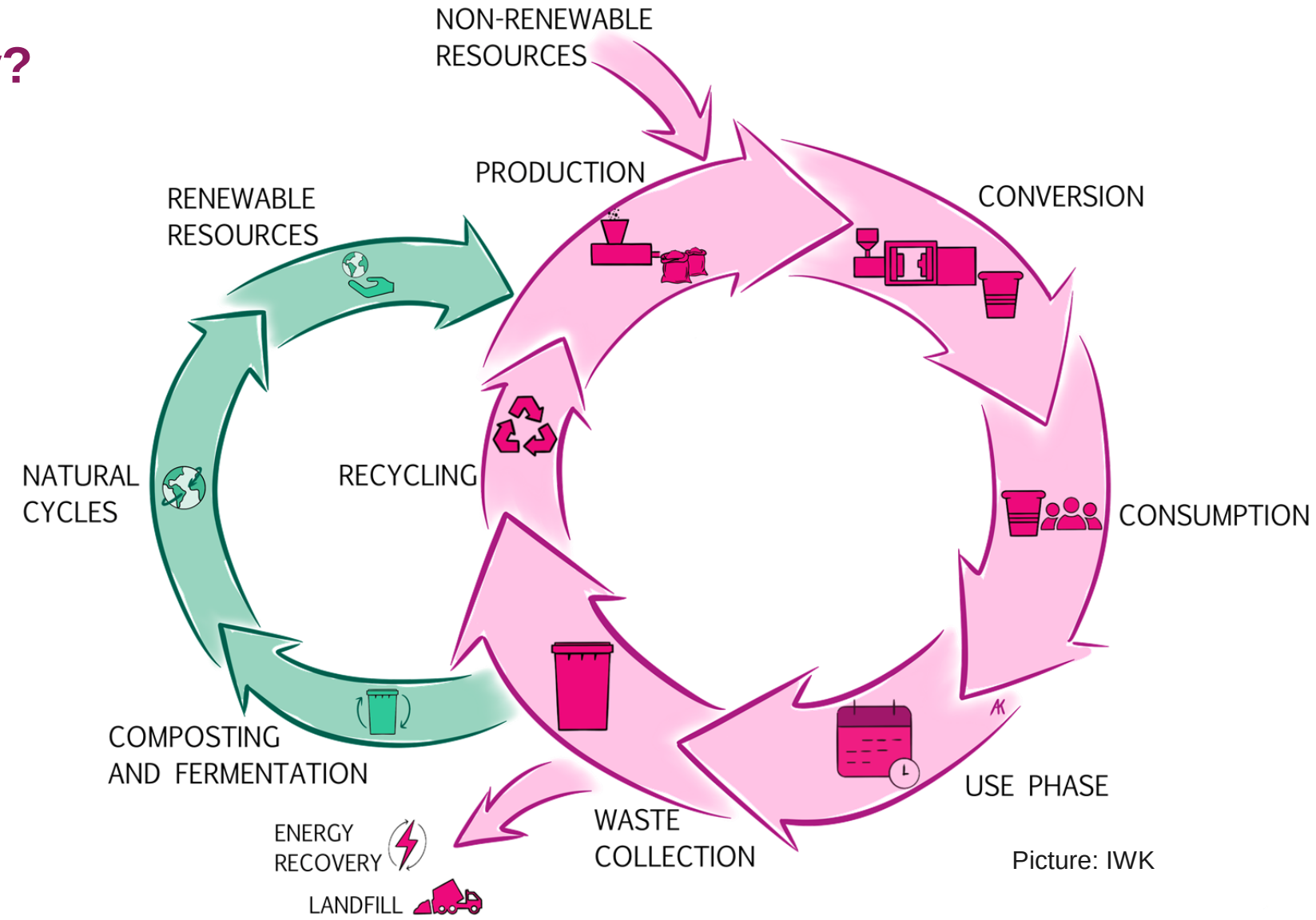
Definition of potential use!

Picture: IWK

Goal: Give waste a value!!!

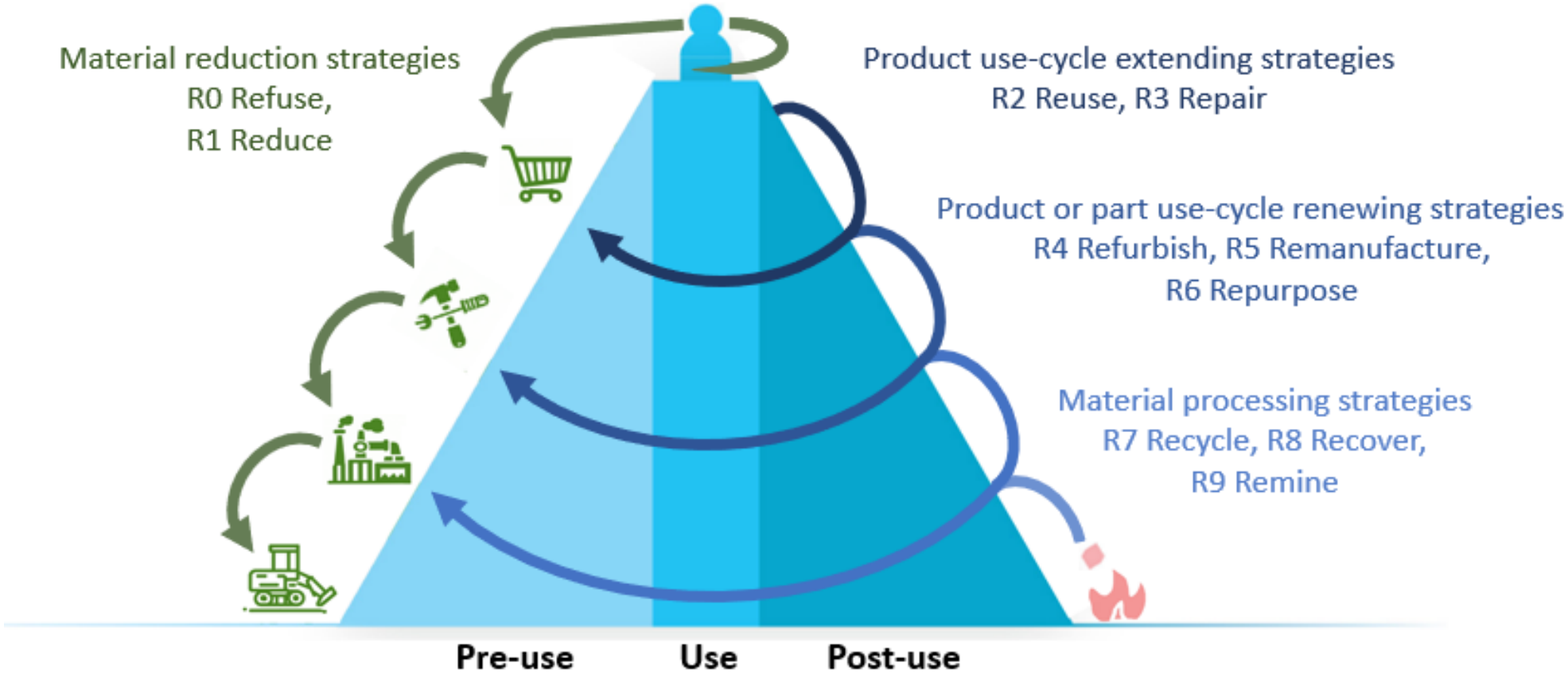
Why circular economy?

Development
from the linear
economic system
to the
circular economy



Picture: IWK

Future: Creation and preservation of value.

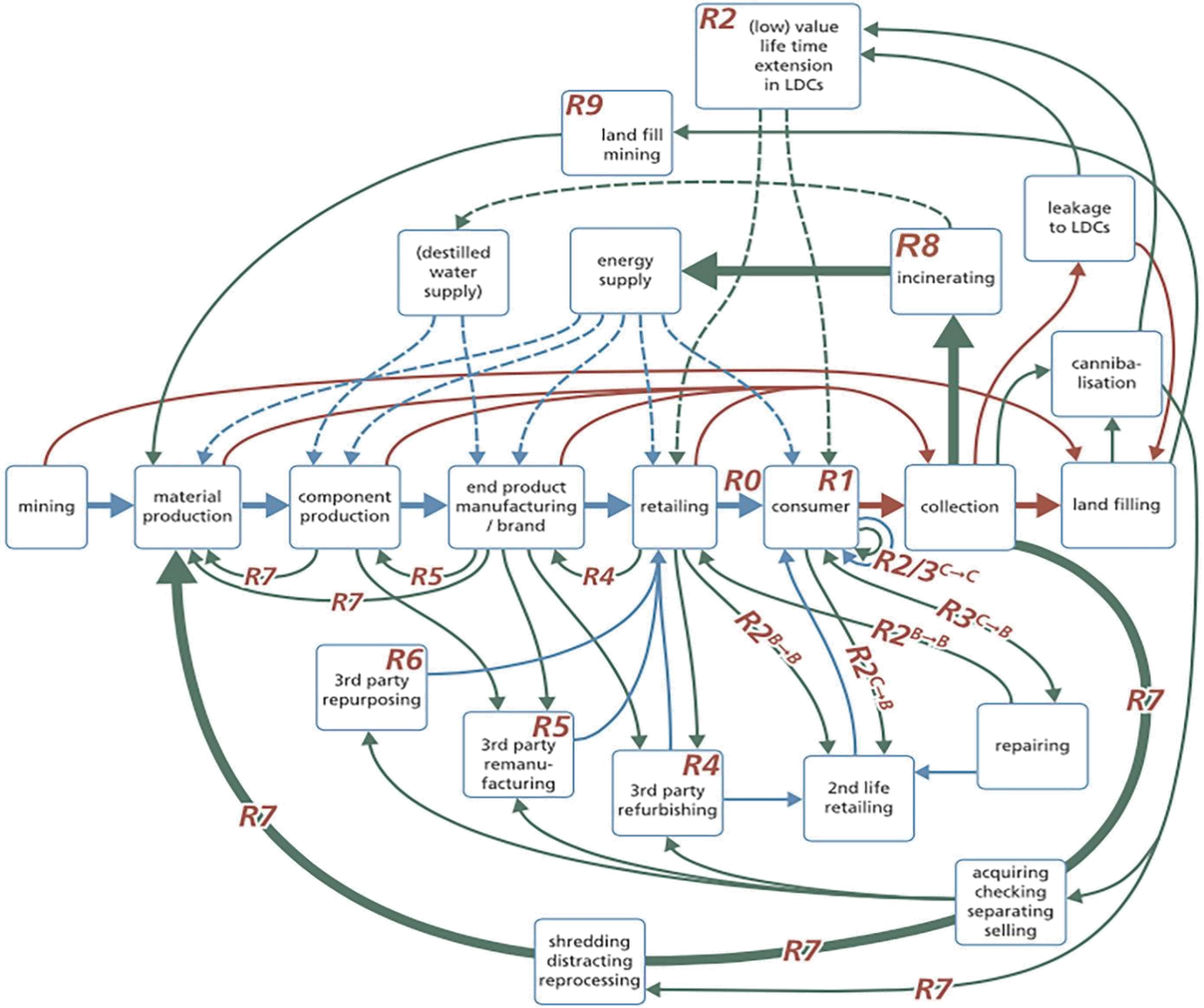


Quelle: Nicolas Hofer et al. in Podleisek/Hänggi/Luban 2023 (unpublished) based on Achterberg/Hinfelaar/Bocken (2016)

Circular economy

R0→R9: Hierarchy of CE value retention options (RO's) for consumers and businesses

R0 = Refuse	*R5 = Remanufacture*	(C = consumer)
R1 = Reduce	*R6 = Re-purpose*	(B = business)
R2 = Resell, reuse	*R7 = Recycle materials*	
R3 = Repair	*R8 = Recover energy*	
R4 = Refurbish	*R9 = Re-mine*	



source: Reike, D., Vermeulen, W.J.V., Witjes, S. (2022). https://doi.org/10.1007/978-3-030-94293-9_3,

Schematic rearranged

Circular economy

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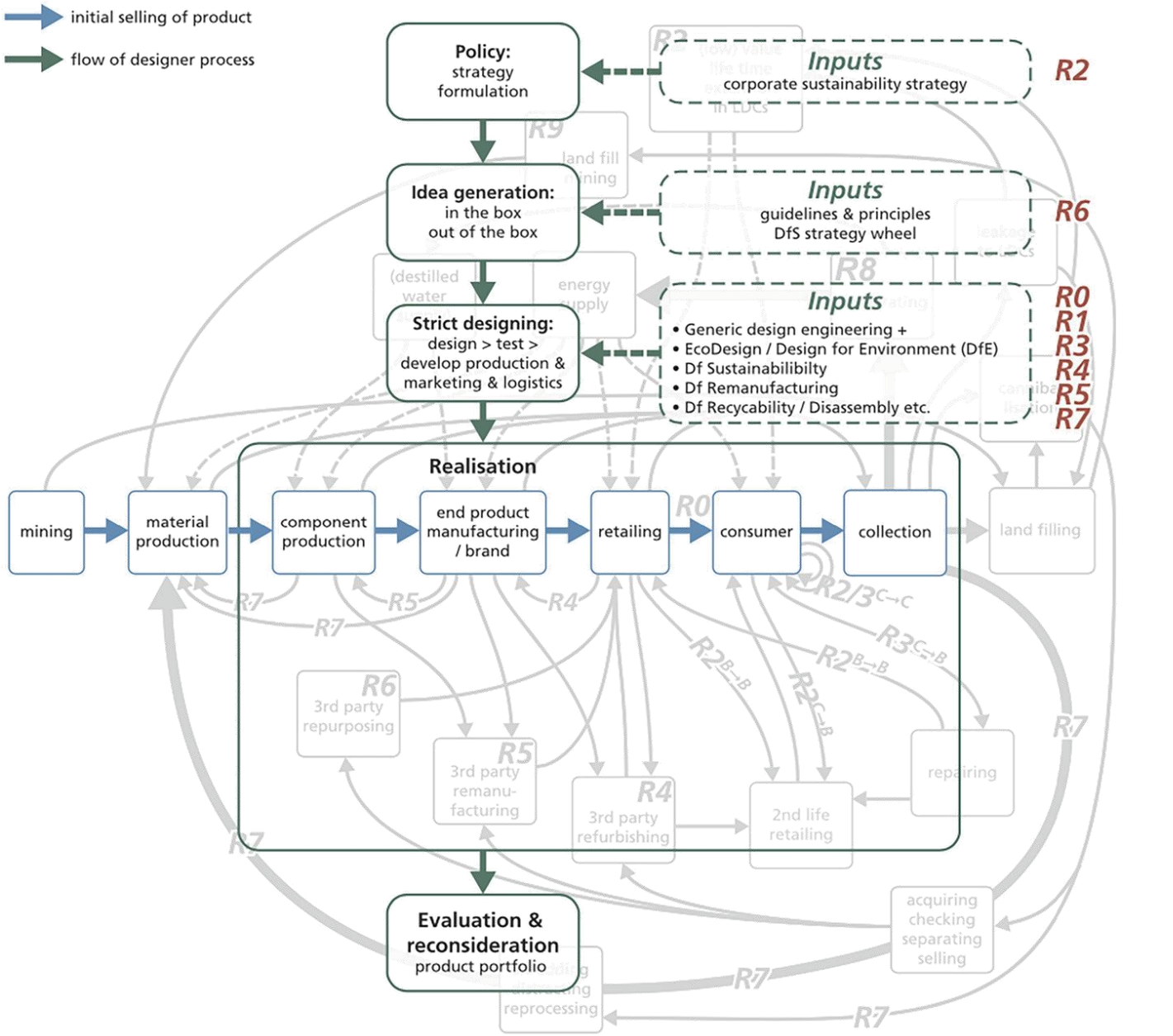
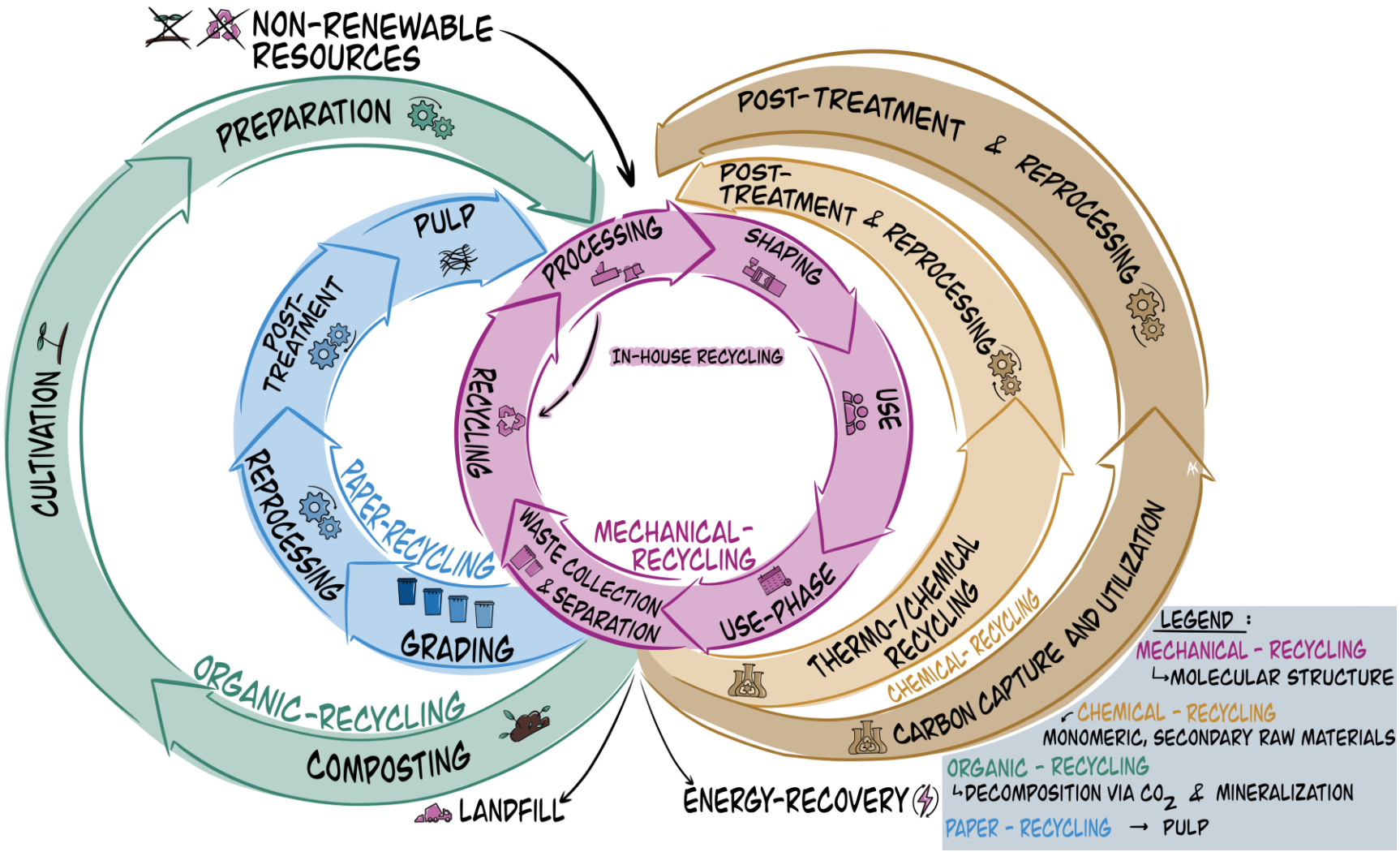


source: Reike, D., Vermeulen, W.J.V., Witjes, S. (2022). https://doi.org/10.1007/978-3-030-94293-9_3,

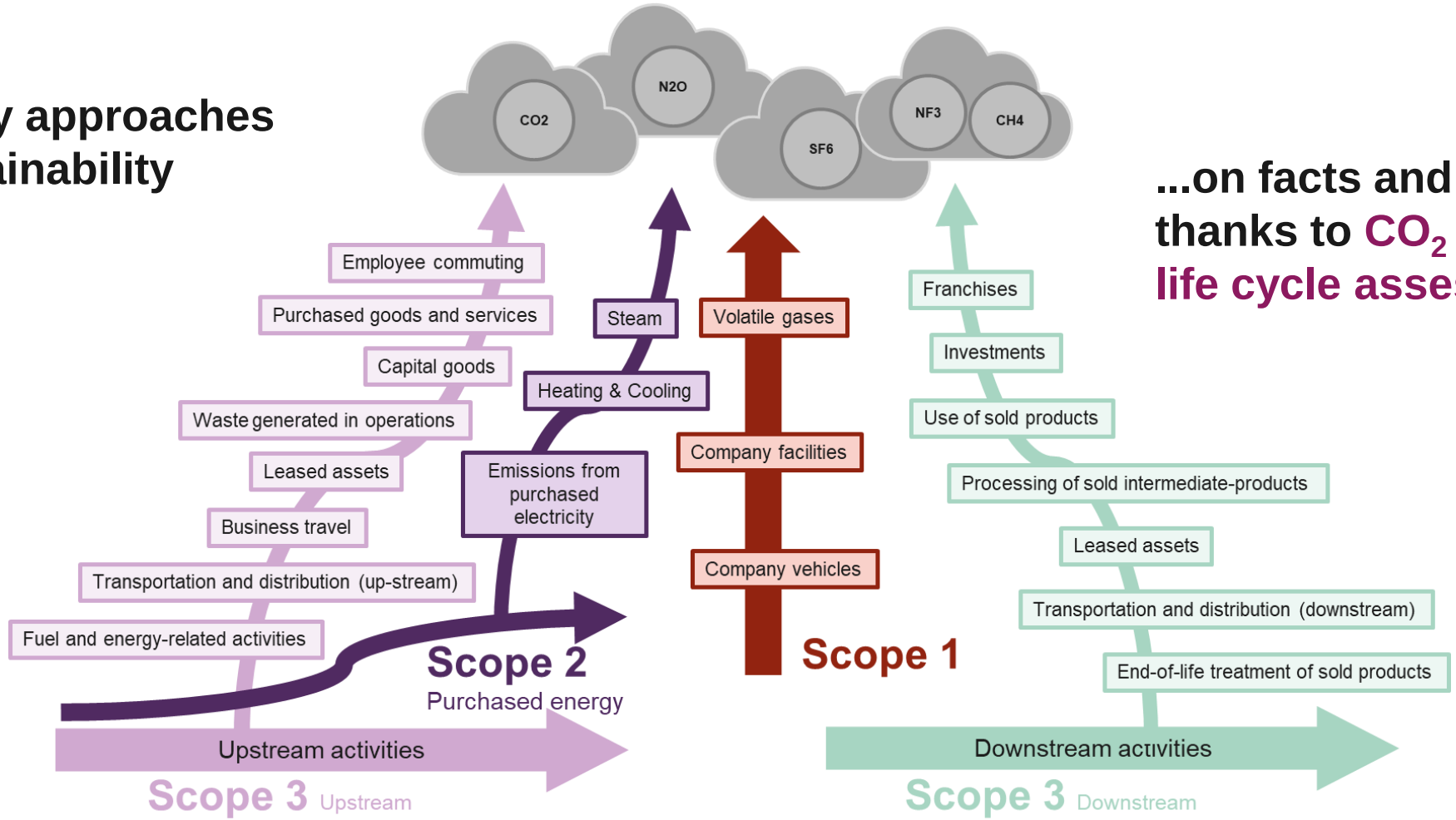
Schematic rearranged

Circular economy – various paths possible



Environmental assessment – making sustainability measurable

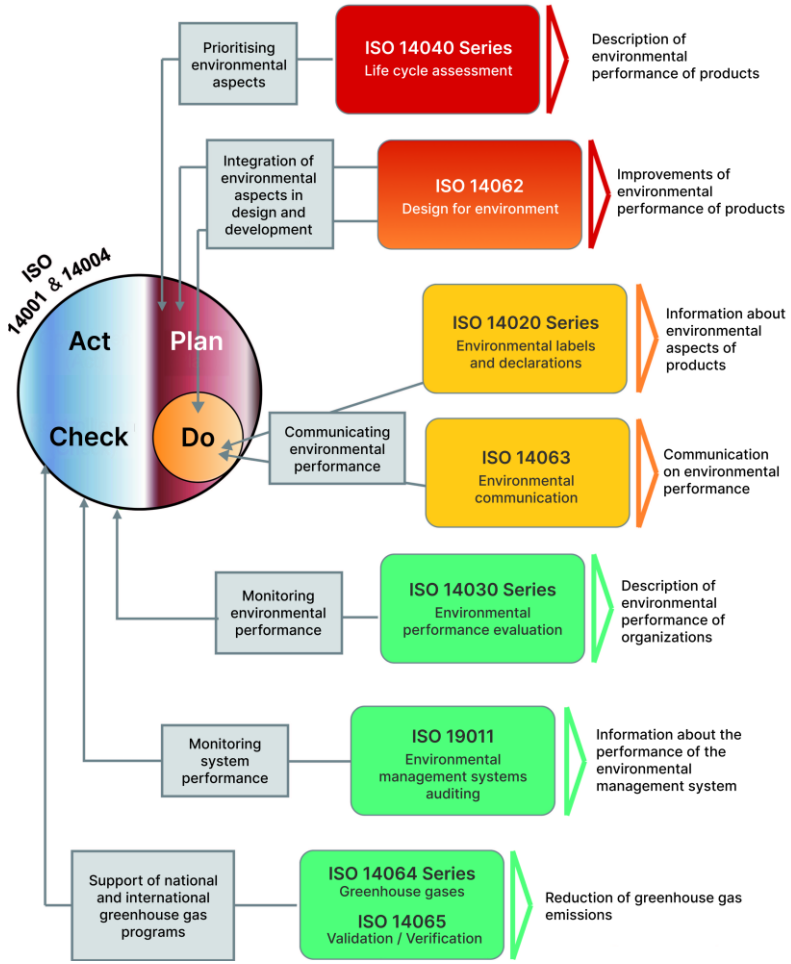
Of many approaches to sustainability



...on facts and figures thanks to CO_2 footprint and life cycle assessment

retraced along: https://allianz-entwicklung-klima.de/toolbox/was-sind-scopes-geltungsbereiche-bei-der-berechnung-der-unternehmensbezogenen-treibhausgasemissionen/

Environmental assessment – making sustainability measurable



Do good and talk about it – But how?

Definition target group

Legislation **Customers** **Company internal**

Calculation of environmental impact using LCA, CO_2 footprint,

We are happy to support.

Project examples

From old skiboots to iphone cases

Recycling process from ski boots to the sustainable phone-case „F385 CIRC-CASE“

1 Manual disassambly in individual parts and separation of metal and rubber

2 Plastic analysis with FTIR, material and color separation

3 Grinding

ARGO
WIR STÄRKEN PERSÖNLICHKEITEN

4 Melting and compounding to plastic pellets

OST Eastern Switzerland University of Applied Sciences

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5 Tool design and and injection moulding of the F385 Circ-Cases

6 Customization of the phone-case with F380 Justin

FREITAG

Ocean Bound Plastics Recycling

Tide Ocean Material




Ocean Bound Plastics

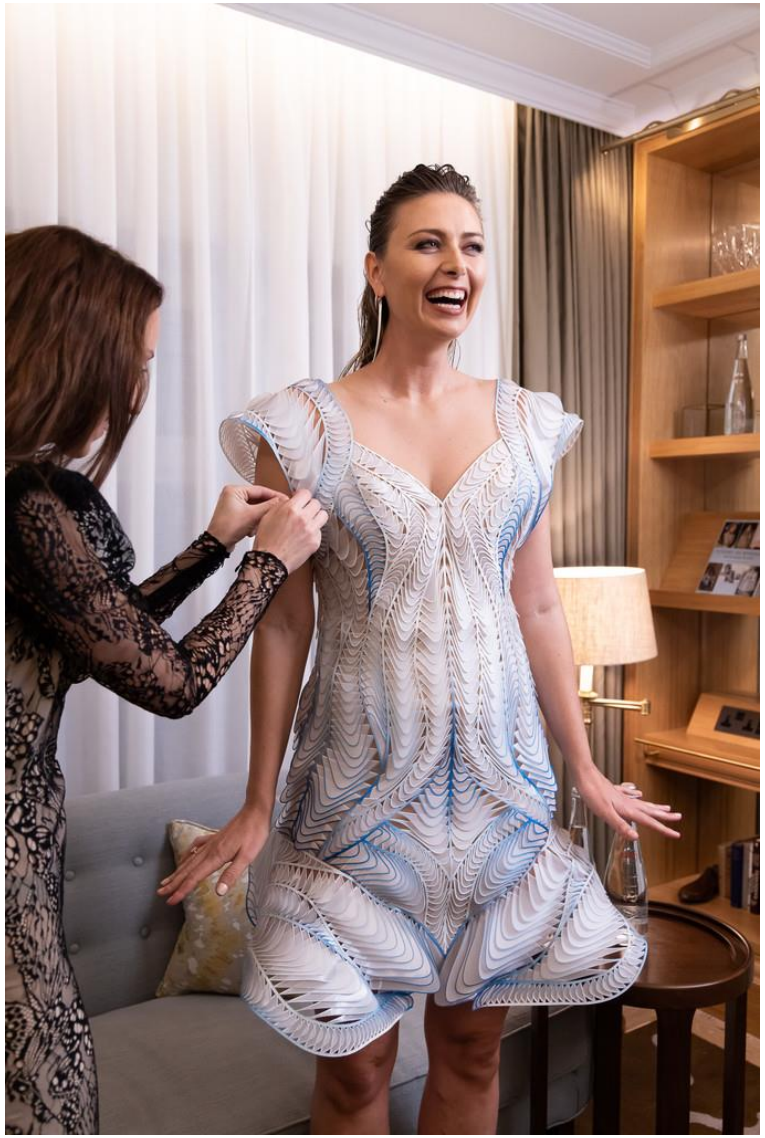
Bild: Mibelle

Bilder: Ocean Yarn by Meister

Bild: Maurice Lacroix

Bilder: Condor, tide ocean material

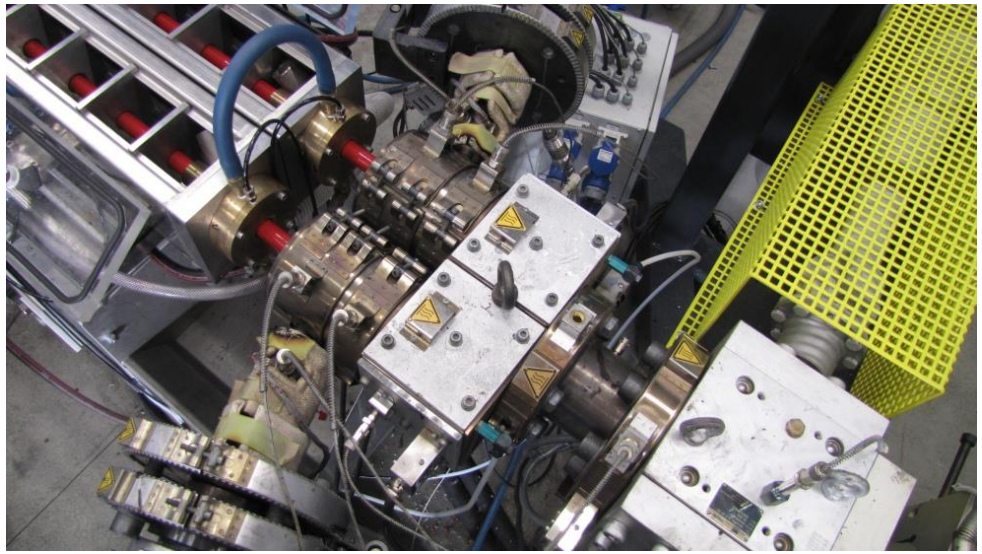
Solaris - Evian – Iris van Herpen Project



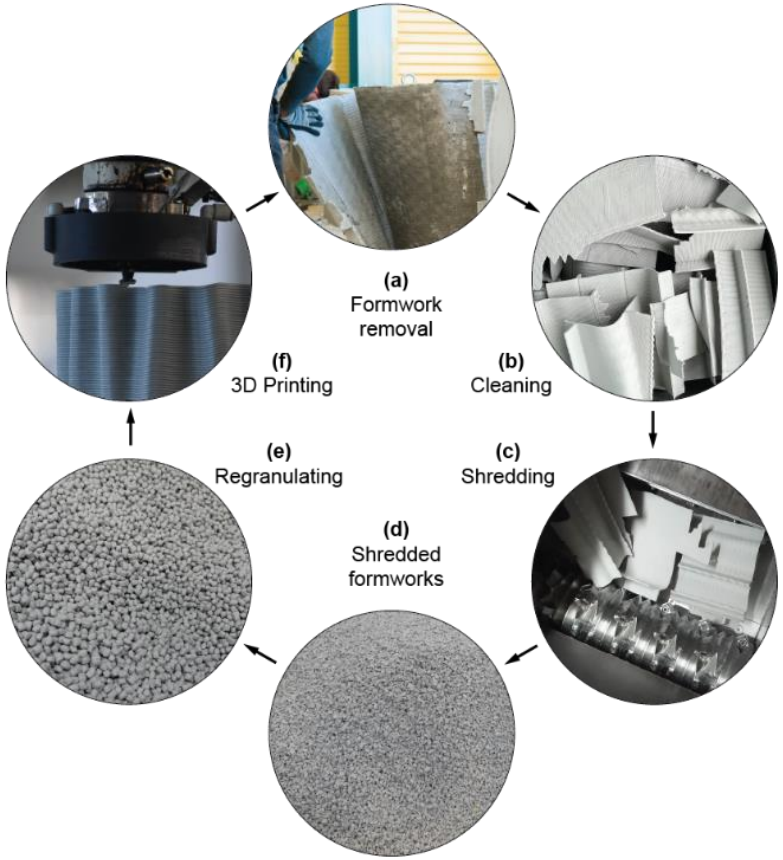
[Maria Sharapova and Iris van Herpen Turned Evian Bottles Into Haute Couture for the British Fashion Awards | Vogue]

In-line Extrusion of sticks
Recycling of packaging materials

sp·berner
RECYCLED PLASTIC SOLUTIONS



Recycling of 3D Printed concrete formworks together with ETH Zürich



Circular Formwork: Recycling of 3D Printed Thermoplastic Formworks for Concrete Construction in Architecture

Article *in*
Technology|Architecture + Design · November 2023

Joris Burger, Ena Lloret, Marc Akermann, Daniel Schwendemann, Fabio Gramazio, Matthias Kohler

Vitra Design Museum

INSTITUTE FOR MATERIALS TECHNOLOGY AND PLASTICS PROCESSING

Thank you very much for your attention

visit us

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daniel.schwendemann@ost.ch
+41 58 257 49 16
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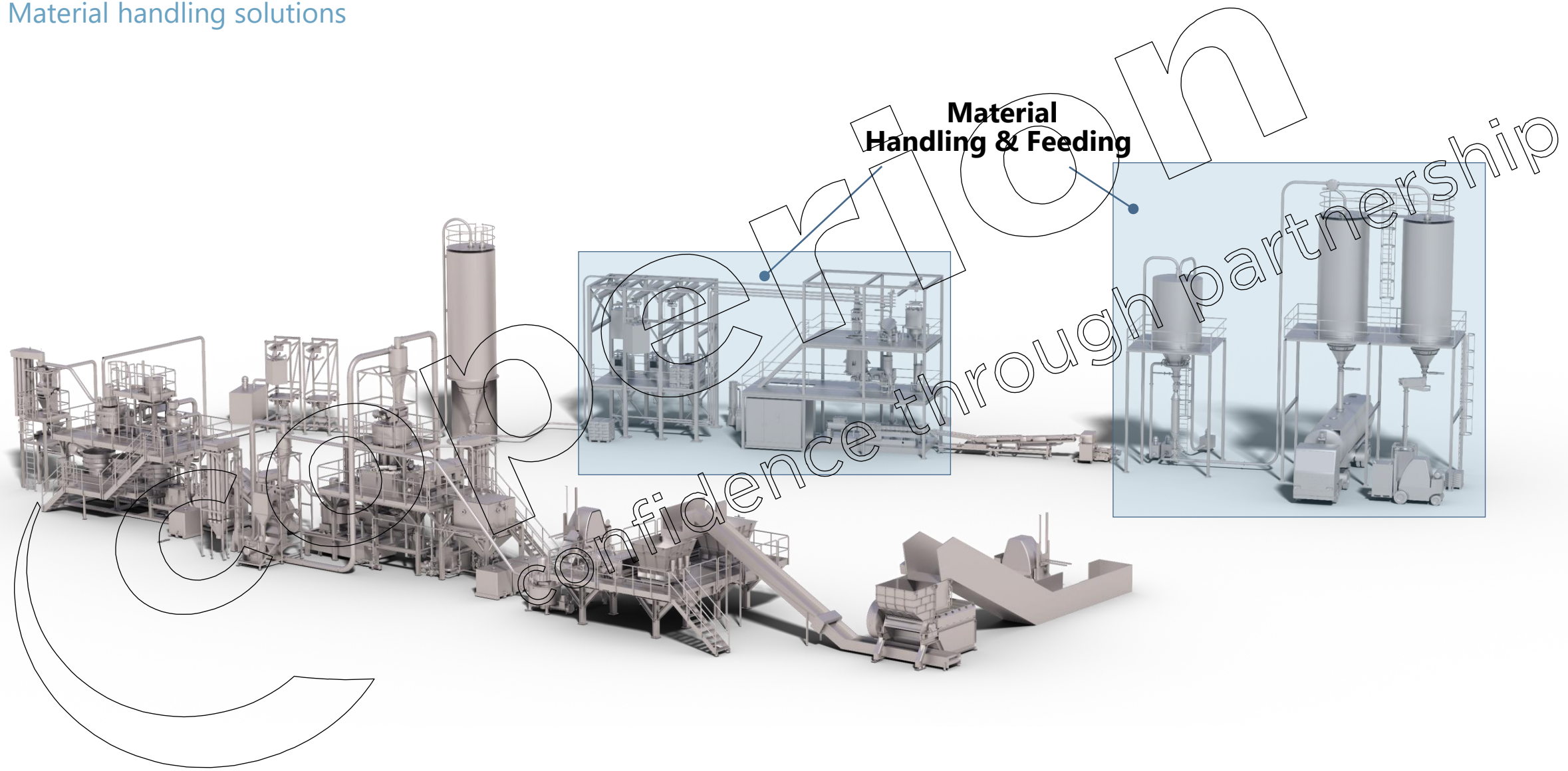
Material Handling, Deodorization and Degassing

State of the Art and Solutions for Recycling Applications

Francesco Arvieri
Sales Manager | Coperion

Core recycling equipment

Material handling solutions



1

FLUIDLIFT ecodry

2

Coperion ARW

3

Deodorization

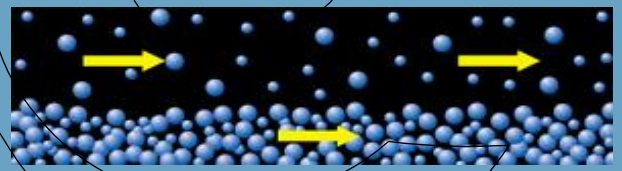
Coperion FLUIDLIFT ecodry

Conveying and drying of recycled raw material

Conveying

Material needs to be transported from washing and milling plant to extruder.

The conveying can be performed either in positive or negative pressure.



Drying

Washing process leaves residual water which can be negative for extrusion. It is mandatory for it to be removed.

Residual water can degrade the products or create inner bubbles.

FLUIDLIFT ecodry

Conveying and Drying in one step.

Hot air for conveying is used for surface water removal while product is brought to extruder.

Drying is so fast (about 1s) that product is not affected by the temperature increase.

Coperion FLUIDLIFT ecodry

Space and energy saving

Benefits

Space saving → No dedicated drying equipment

Energy saving → Hot air already supplied for conveying

Product care → Temperature increase less than 20°C

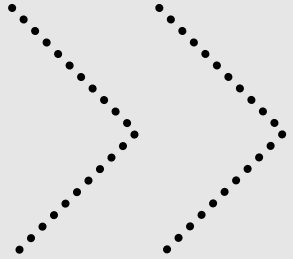
High efficiency → Up to 5% surface moisture removal

Cost saving → Smaller extruder and vacuum pump required

Full product flexibility → Available for pellets and flakes

1

FLUIDLIFT ecodry



2

Coperion ARW

3

Deodorization

ARW System

Recycling cohesive and sticky raw materials

Difficult products

Many products to be recycled are not easy to handle.

Many materials would arrive as thin film or fluffy bales or uneven cut fibers.

Risks

These materials must be handled correctly with proper equipment.

There is risk of bridging in the hoppers, clogging of the pipes and discontinuous flowrate.

Coperion ARW

One of the many equipment in Coperion portfolio is the ARW.

It integrates discharge aid flow control to ensure proper constant operation of the plant.

ARW System

Flexible and customizable discharge system

Benefits

Guaranteed throughput → No risk of bridging or clogging

Full regulation → All systems can change operating speed depending or real line requirements

Feeder integration → Can act as a pre-feeder for smart belt feeder type up to 5000 kg/h

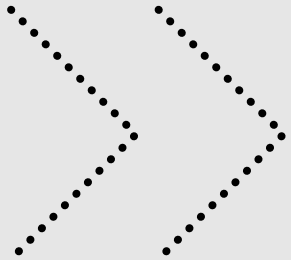
Full flexibility → Different features and accessories depending on actual product handled (shape, BD, thickness, etc)

1

FLUIDLIFT ecodry

2

Coperion ARW



3

Deodorization

Coperion Deodorization

What is smell, how to measure and how to remove it

To deodorize we must know what we want to do

Smell is the emission of volatilized chemical compounds from any source.

There are several ways to measure the smell of a product, following are the most common:

- Lemonine content measured
- Qualitative assessment of odor by 5 trained people
- Total VOC content measured
- VOC and FOG content measured

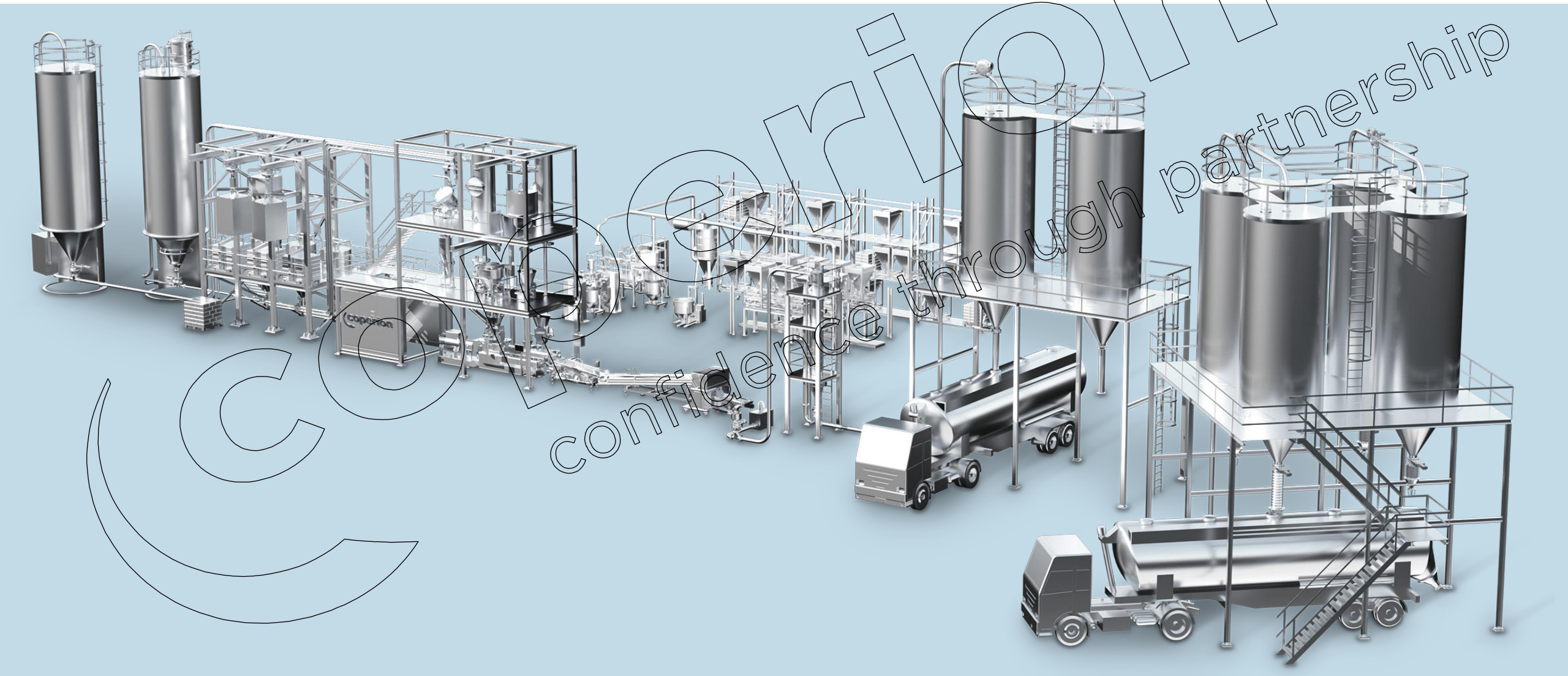
Every smell is emitted with heat

To remove smell, it is required to heat up the material and keep it hot until most of the VOC are expelled by flushing it.

Source: How to Solve the Problem of Plastic Packaging | WIRED:

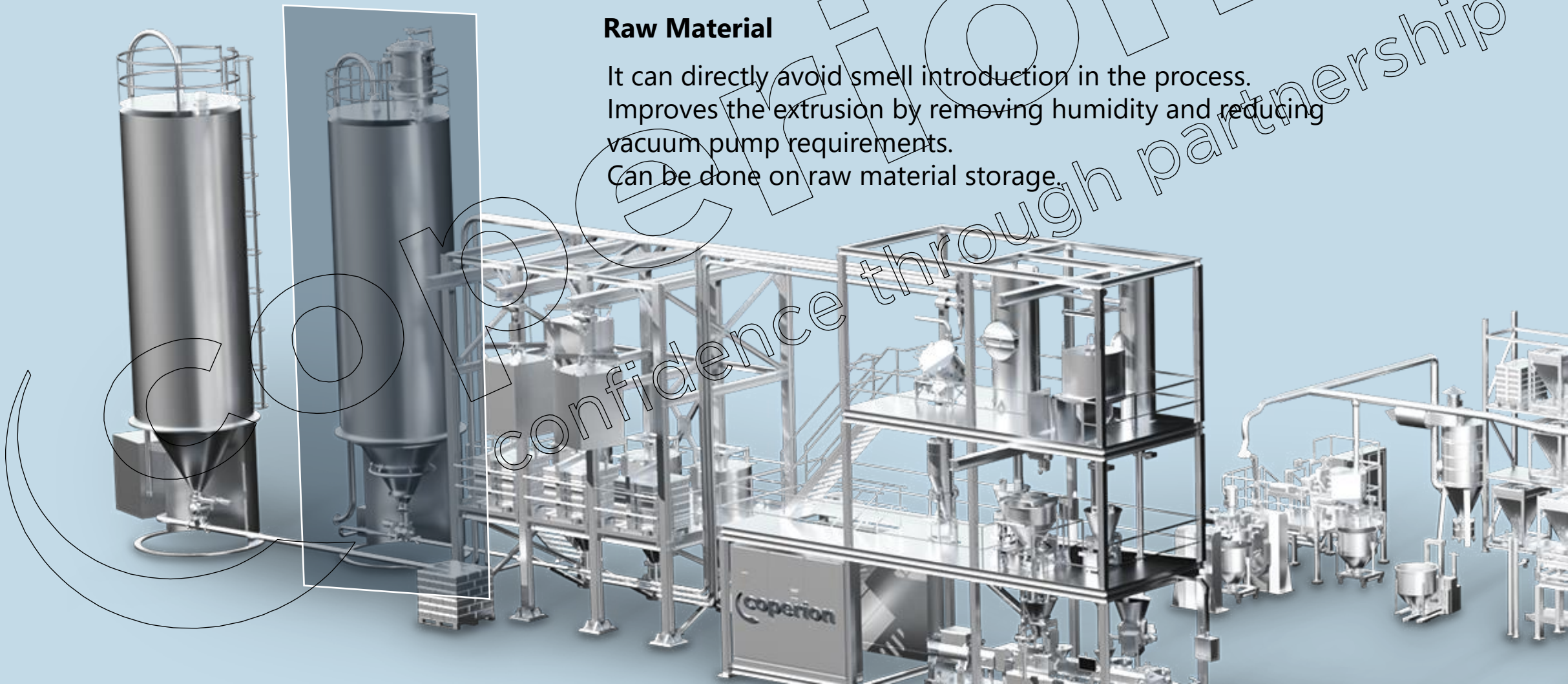
Coperion Deodorization

When to deodorize – impact of different process steps



Coperion Deodorization

When to deodorize – impact of different process steps

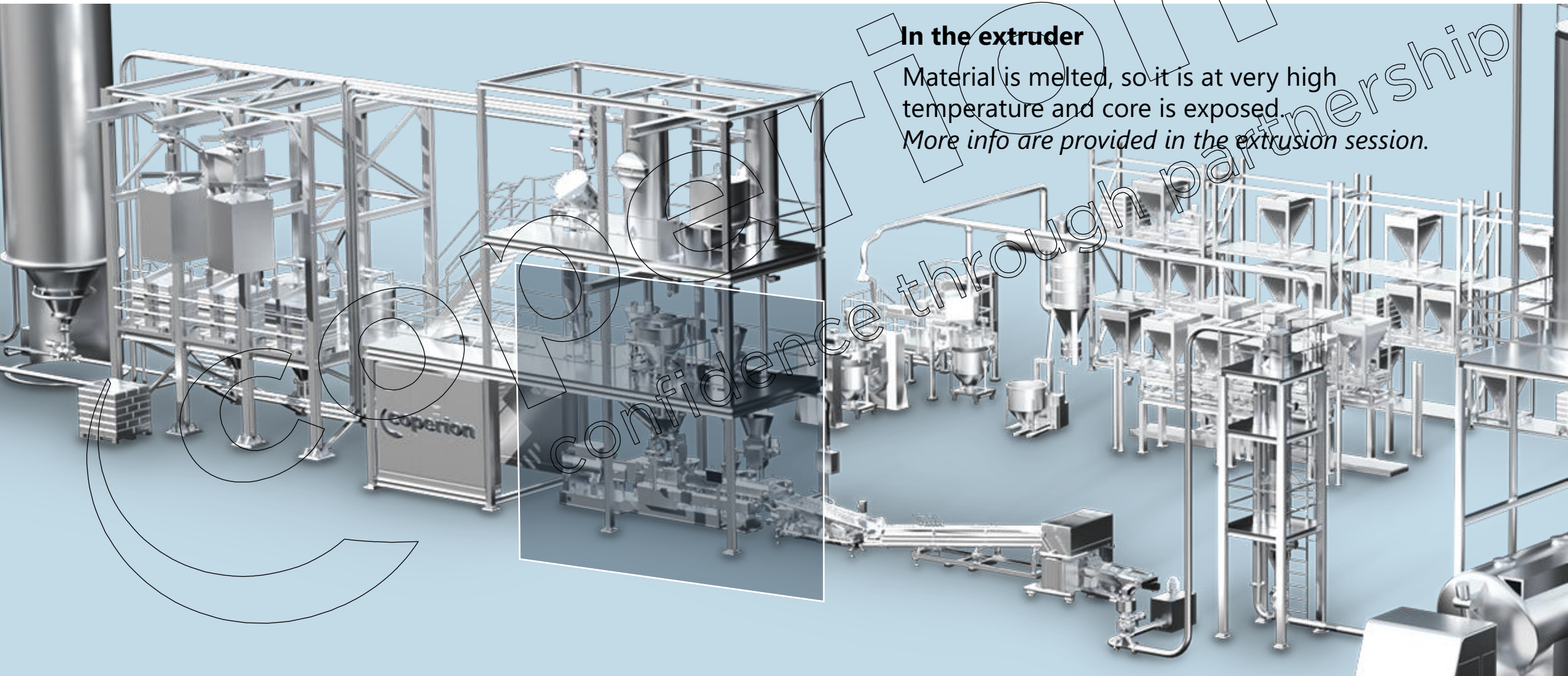


Raw Material

It can directly avoid smell introduction in the process.
Improves the extrusion by removing humidity and reducing vacuum pump requirements.
Can be done on raw material storage.

Coperion Deodorization

When to deodorize – impact of different process steps



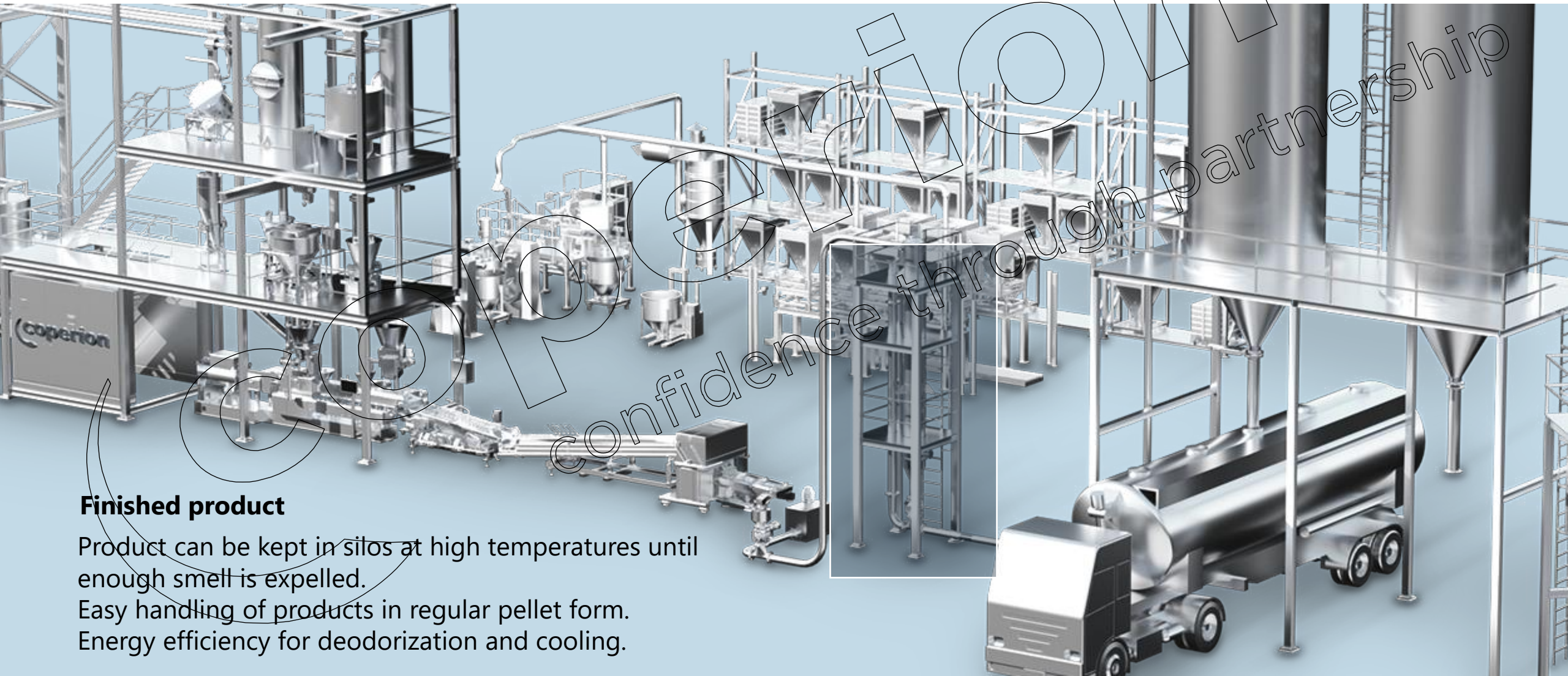
In the extruder

Material is melted, so it is at very high temperature and core is exposed.

More info are provided in the extrusion session.

Coperion Deodorization

When to deodorize – impact of different process steps



Finished product

Product can be kept in silos at high temperatures until enough smell is expelled.
Easy handling of products in regular pellet form.
Energy efficiency for deodorization and cooling.

Coperion Deodorization

Equipment involved - flexibility in sizing

1. **Conveying from extrusion**
2. **Deodorization silo with thermal insulation**
3. **Cooling silo**
4. **Air treatment equipment**
5. **Bagging area**

Coperion Deodorization

Flexible and customizable deodorization system

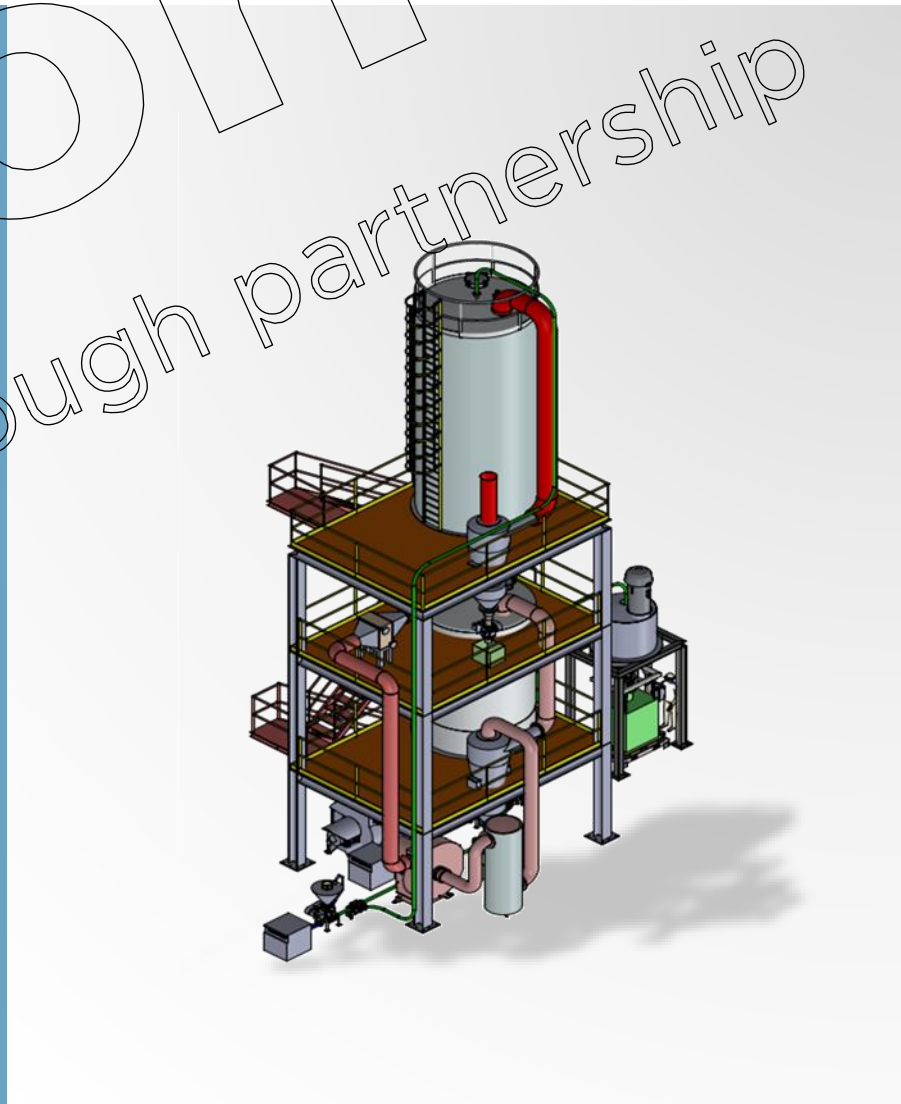
Benefits

Full flexibility → Residence time and temperature can be adjusted as required

Energy saving → Actual heating required low

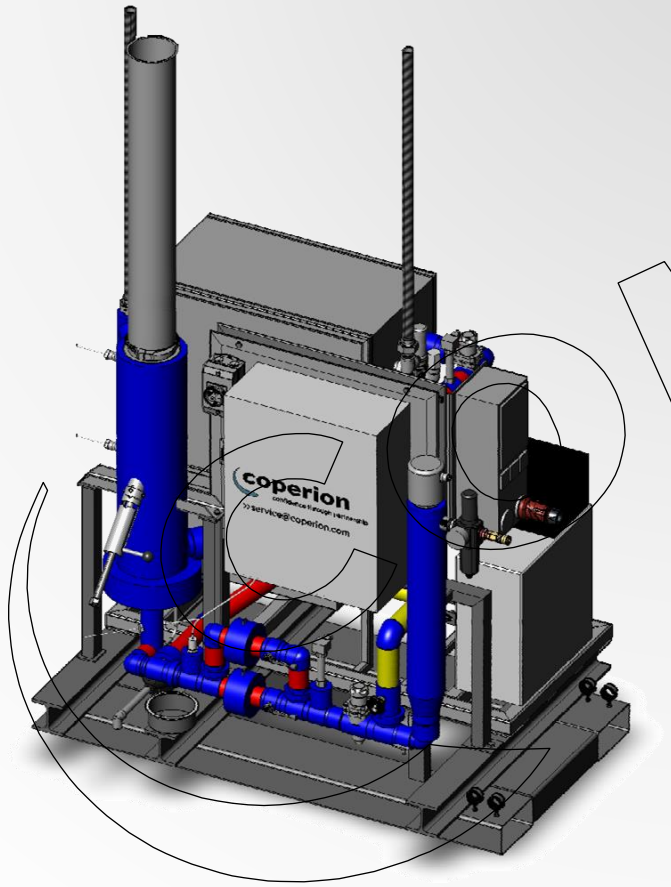
Repurposeability → Same system can be applied everywhere (raw material, finished product, existing lines)

Continuous operation → No middle product storage required



Coperion Deodorization

Coperion lab testing equipment



Testing facility

Batch operation test → Small product sample required

Heating fluids testing → Can be evaluated usage of steam or hot air

Detailed results → Optimiziation of temperature and residence time for best results

Recap

Coperion Material Handling Benefits

FLUIDLIFT ecodry

- Energy saving
- Cost saving
- High efficiency

ARW System

- Flow guaranteed
- Flexible configuration
- Full adjustability

Depdorization

- Flexible application
- Energy efficiency
- Setpoint definition testing

Thank you!

Francesco Arvieri
Sales Manager | Coperion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Application Deep Dive:
Highest Quality in Flexible Film Recycling with Coperion Recycling Technology

Olivier Logeat
Directeur Operations Plastiques
SUEZ RV France SA

Marina Matta
Team Leader Process Technology – Recycling
Coperion

SUEZ PLASTIC RECYCLING

Herbold - Coperion Recycling days

November 07 2024

SUMMARY

1.SUEZ PLASTIC RECYCLING OVERVIEW

PLANTS & LABORATORIES DEDICATED TO OUR INDUSTRIAL CUSTOMERS

A mature expertise to produce and market 110 kt of high-quality recycled raw materials.

215 employees

4 dedicated plants

1 research center

LDPE

SUEZ RV Plastiques
Landemont plant (49)

4 PEBD

PET

SUEZ RV Plastiques Atlantique
Bayonne plant (64)

France Plastiques Recyclage
Limay plant (78)

1 PET

Plast'lab

A research center dedicated to recycled plastics

PVC

SUEZ RV Plastiques
Vernie plant (72)

3 PVC

2.

TWENTY YO EXPERIENCE OF LDPE

Landemont plant

PE plastic recycling

75
employees
working in 5 teams

70 000 m²
Of surface
including 15 000 m² covered

Site IPCE
Installation Classée pour la Protection de l'Environnement

Certification ISO 9001 – 2015

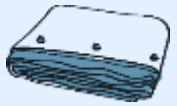
RecyClass

2 waste deposits

Agricultural films
Pays de la Loire

24 600 exploitations

surface agricole utile : 2,2 millions d'hectares



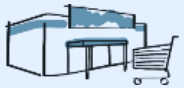
12 kt films plastiques agricoles collectés par ADIVALOR

38 000 t/an
of recycled materials

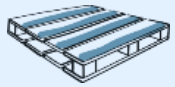
18 800 t/an
of recycled materials produced

Commercial PE films
France

2 catégories de PE de suremballage traitées :



DAE



films 98/2

22 000 t/an
of recycled materials

15 200 t/an
of recycled materials produced

Industrial & technical uses

- Building film, agricultural film, bubble film
- Reusable shopping bags, garbage can bags, recycling bags
- Tubes, irrigation sheaths
- Components for the automotive industry

3.

1.LATEST PROJECT: LANDEMONT

Landemont projet: to triple production

Site first established in 1999 exclusively on agricultural film recycling

First post commercial line in 2019

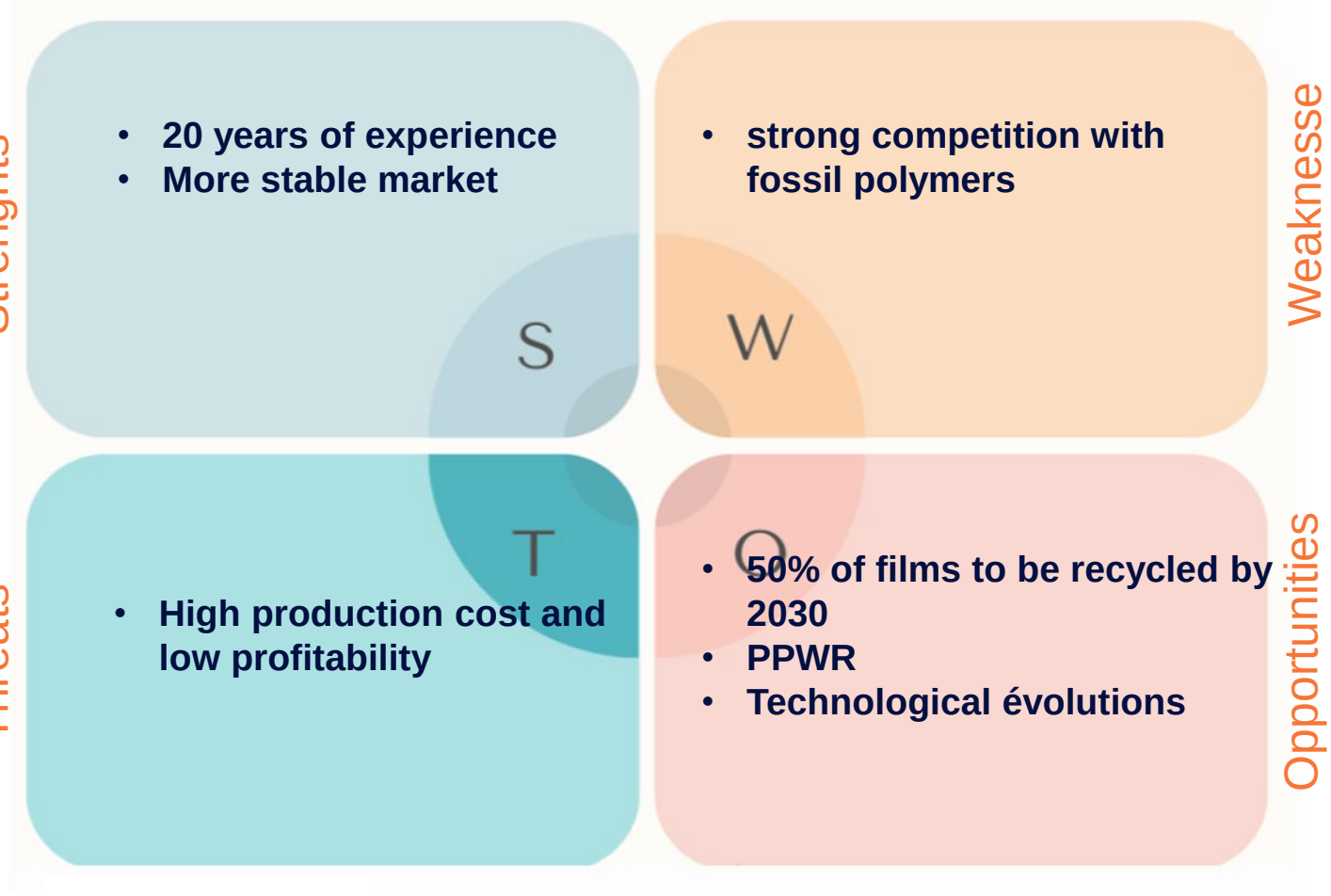
30M€ investment in 2022 to modernize and increase capacity

Previous perimeter		New perimeter	
29kt input	of waste materials	60kt input	of waste materials
11kt output	of recycled materials	34kt output	of recycled materials
55 FTEs		75 FTEs	
3 production lines		5 production lines	

4.

MARKET EVOLUTIONS AND STRATEGY

PLANTS & LABORATORIES DEDICATED TO OUR INDUSTRIAL CUSTOMERS



- 20 years of experience
- More stable market

- strong competition with fossil polymers

- High production cost and low profitability

- 50% of films to be recycled by 2030
- PPWR
- Technological évolutions

→ Aim for increase profitability through technological innovation

CONTACT

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suez.com

CREATING CYCLES. FOR LIFE.

**Créer des cycles. Pour la vie.*

suez.com

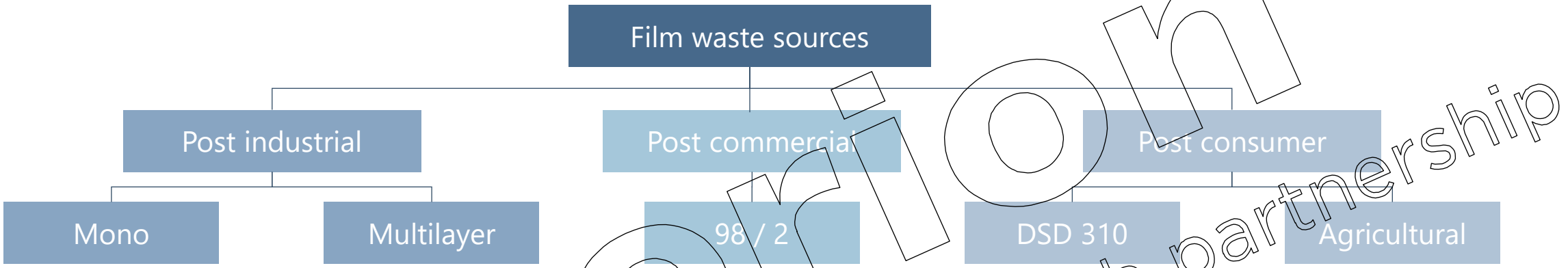

HERBOLD
MECKESHEIM
coperion

Application Deep Dive:
Highest Quality in Flexible Film Recycling with Coperion Recycling Technology

Olivier Logeat
Directeur Operations Plastiques
SUEZ RV France SA

Marina Matta
Team Leader Process Technology – Recycling
Coperion

Challenges for film recycling



Quality challenges

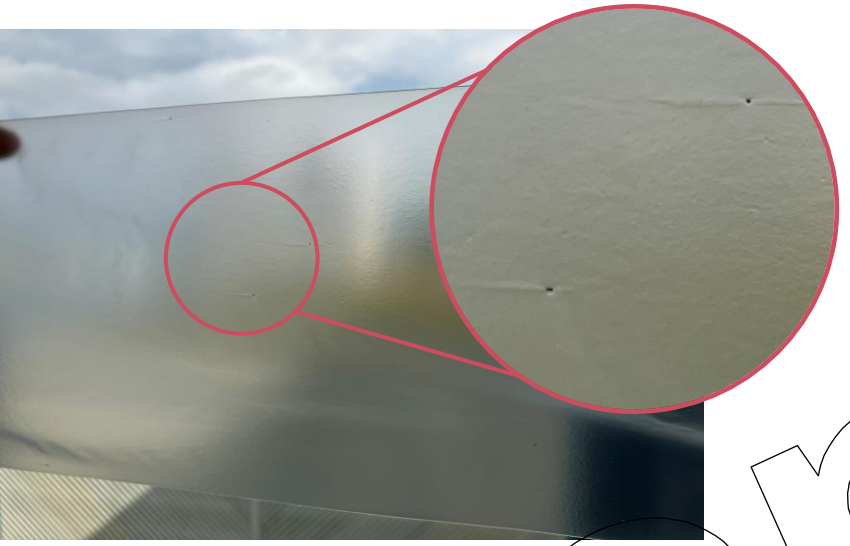
- Gels and contaminants
- Smell
- Discoloration

Handling challenges

- Low bulk density - 15-50 kg/m³
- Compacting and bridging properties

Focus on: QUALITY

Film defects



Brown appearance

- Oxidized resins
- Wood
- Paper

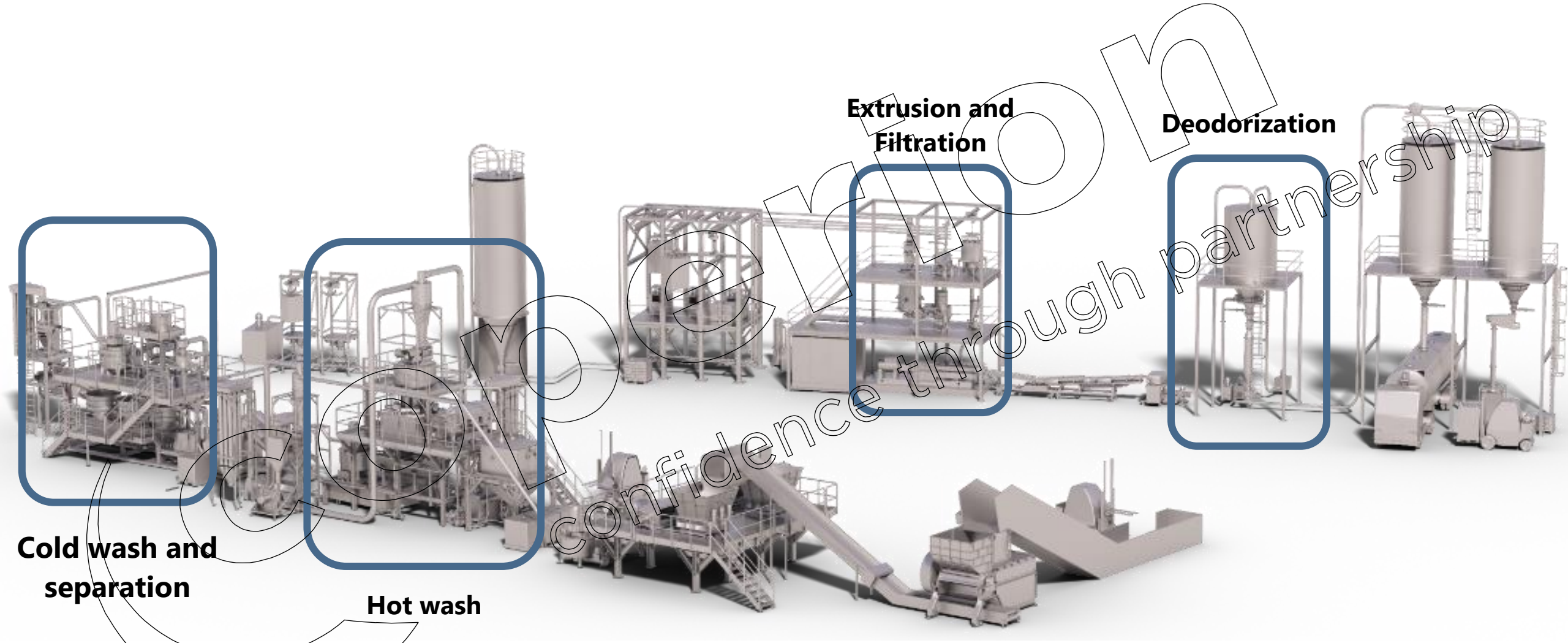
Glassy appearance

- Crosslinked resin
- Foreign polymers

Opaque appearance

- Inorganic contamination
- Pigments
- Paper

Challenges for film recycling



Challenges for film recycling

Cold wash and separation

Hot wash

Focus on: QUALITY

Hydrocyclone + Hot Wash

Swim Sink Tank

Hydrocyclone

Cold Wash

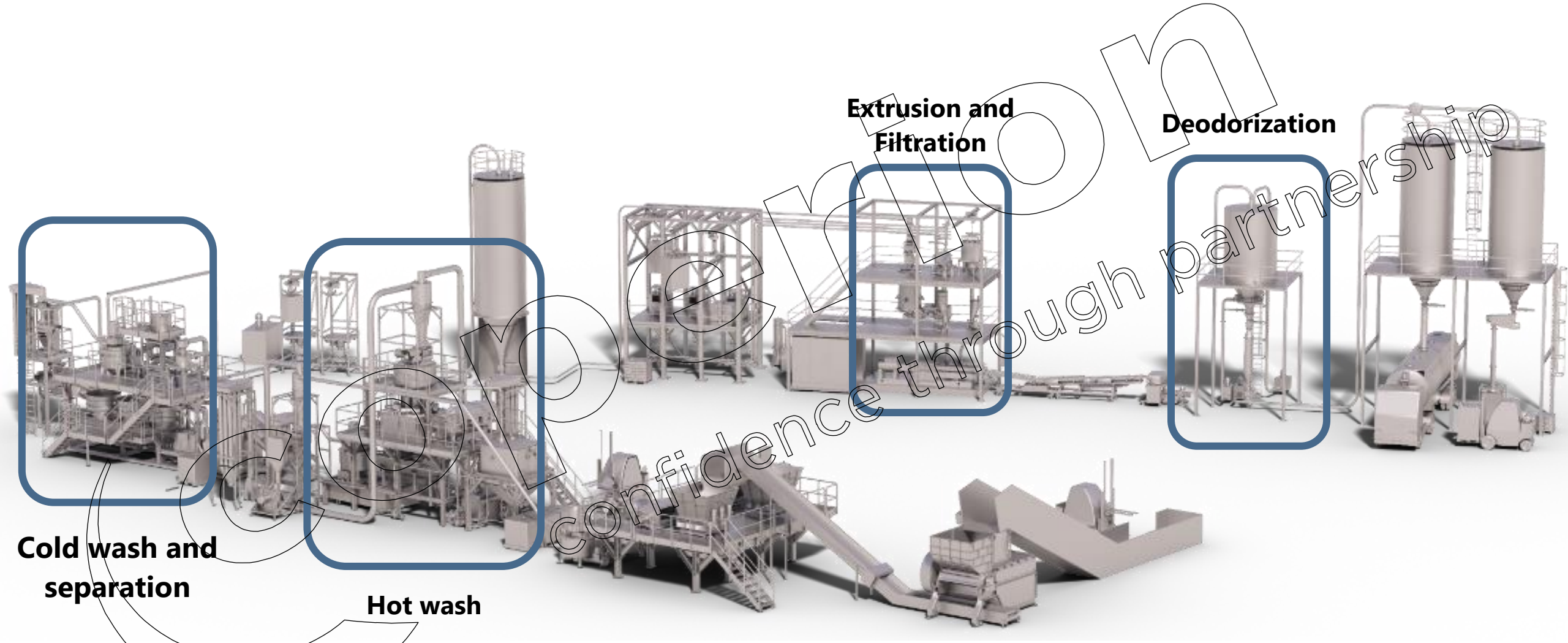
Hot Wash

Reduces the number of defects in the end product

Improves transparency by reducing adhesive content

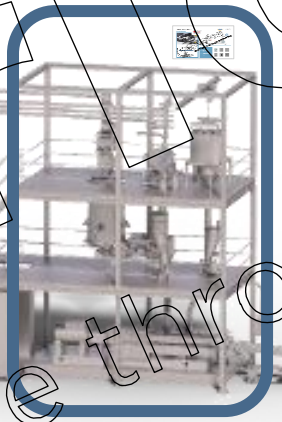
Quality improvement with Hydrocyclone + Hot Wash

Challenges for film recycling



Challenges for film recycling

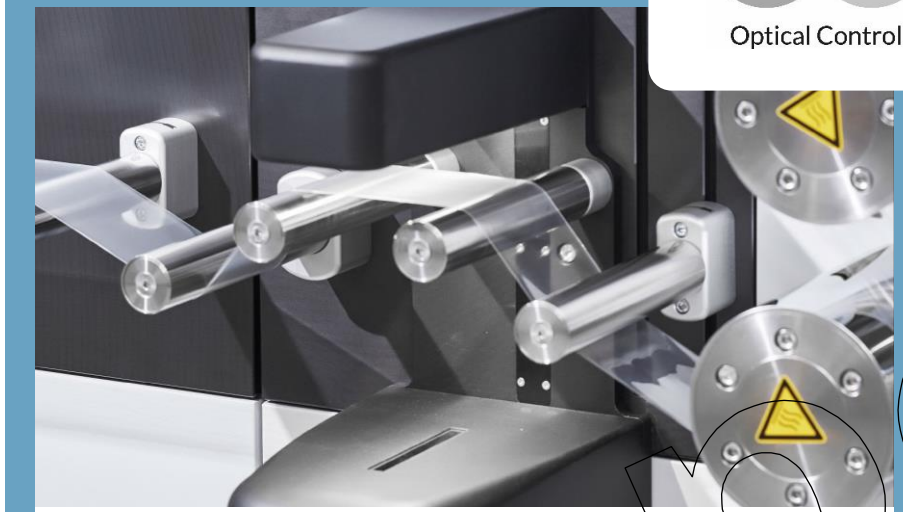
Extrusion and Filtration

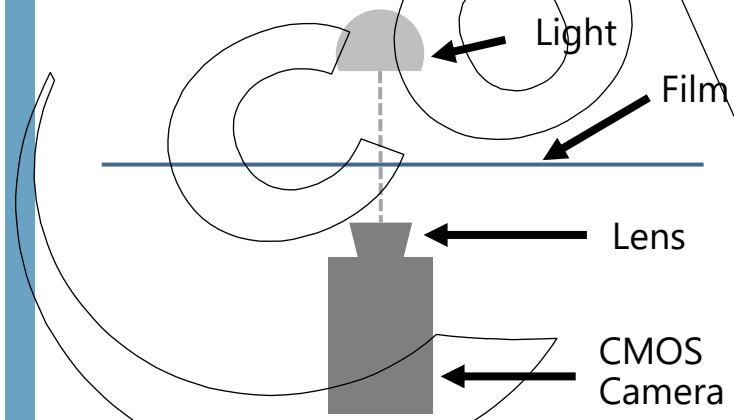


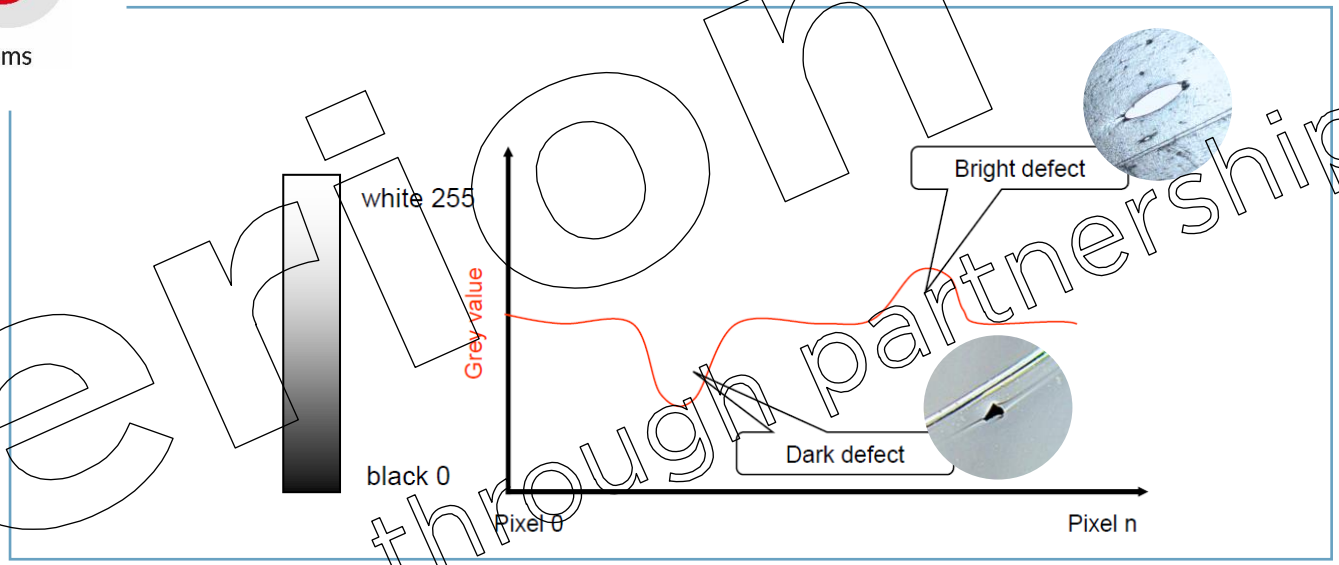
Focus on: QUALITY

How to quantify gels

Optical Control Systems

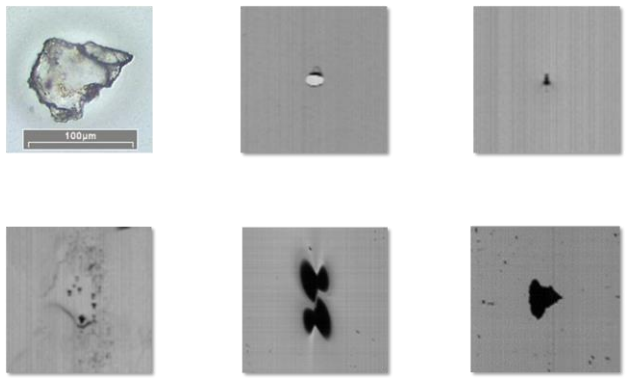






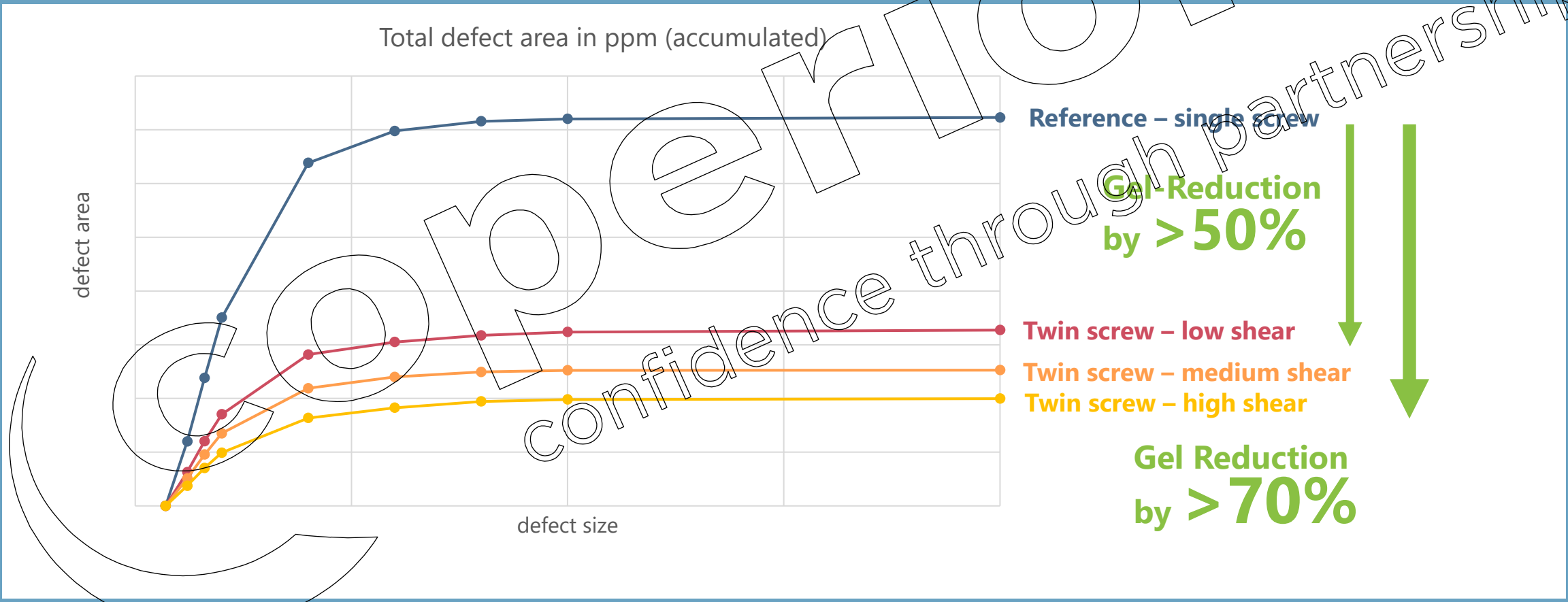
Detect:

- Back specs
- Gels
- Contaminations
- Agglomerates



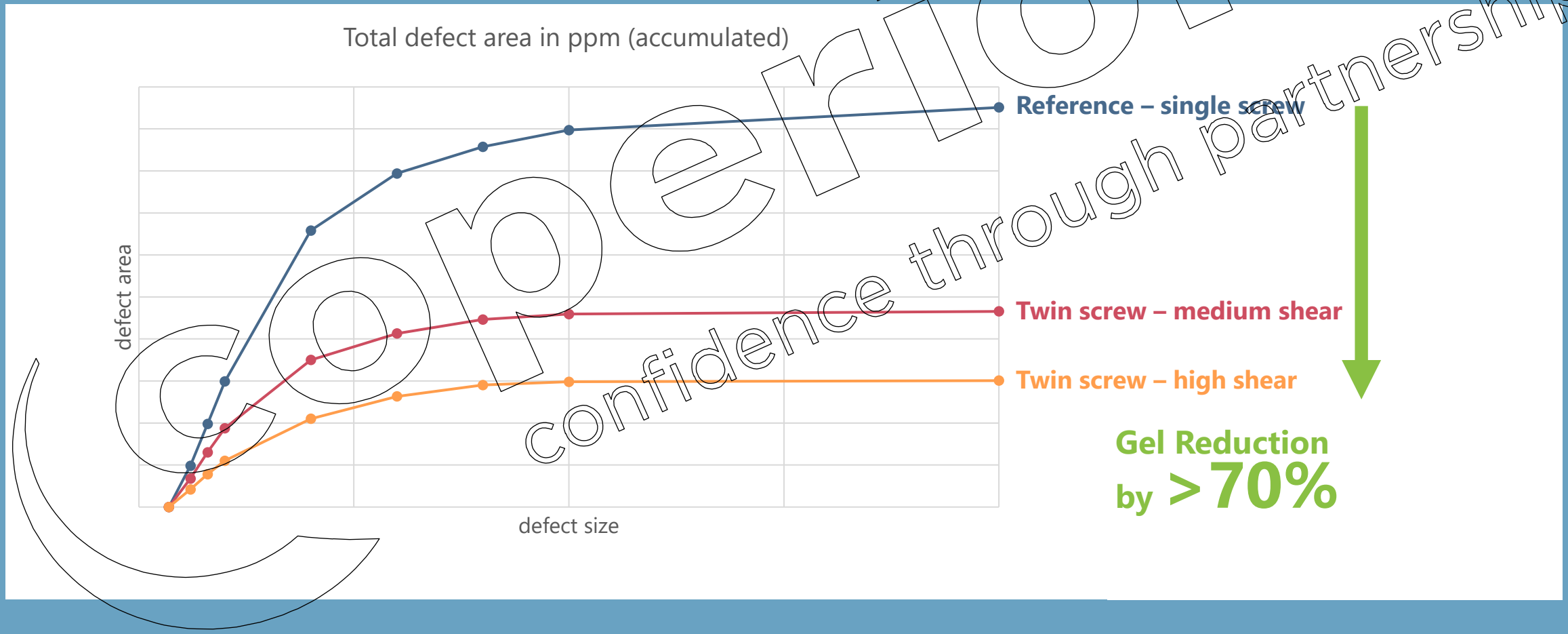
Focus on: QUALITY

Process parameters – Supermarket film



Focus on: QUALITY

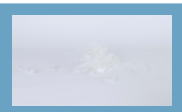
Process parameters – Post-consumer film - 310

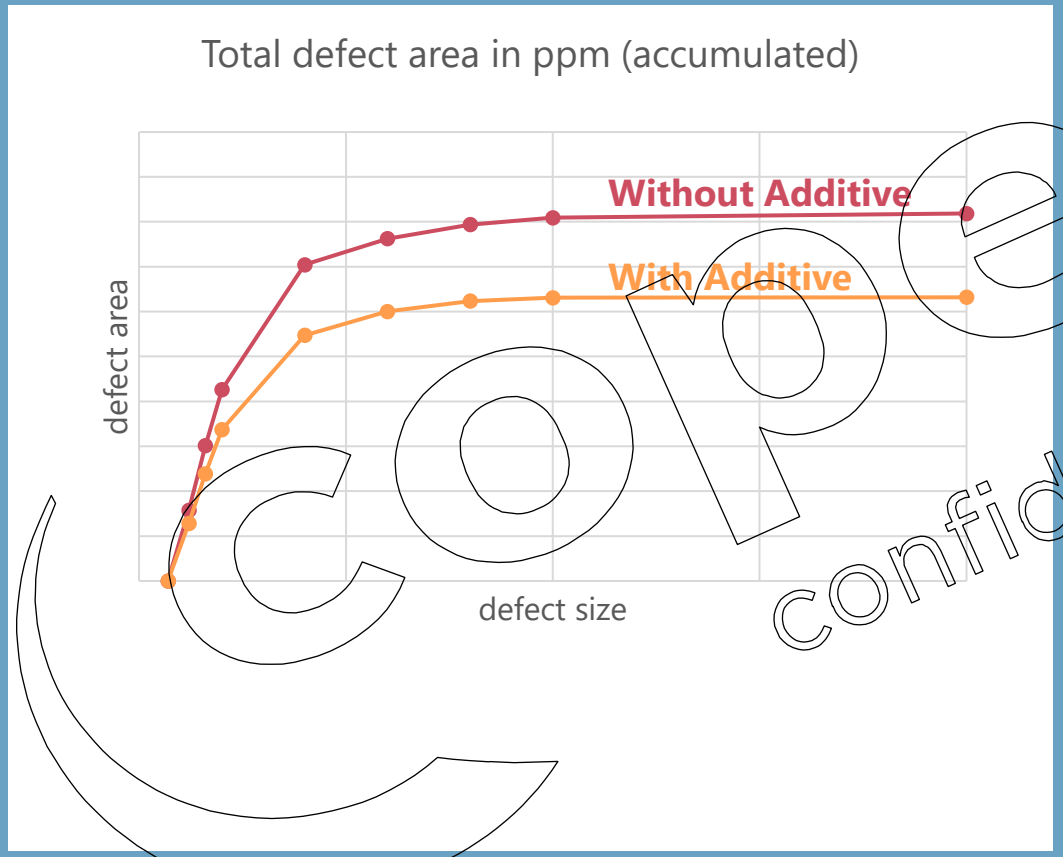


Focus on: QUALITY

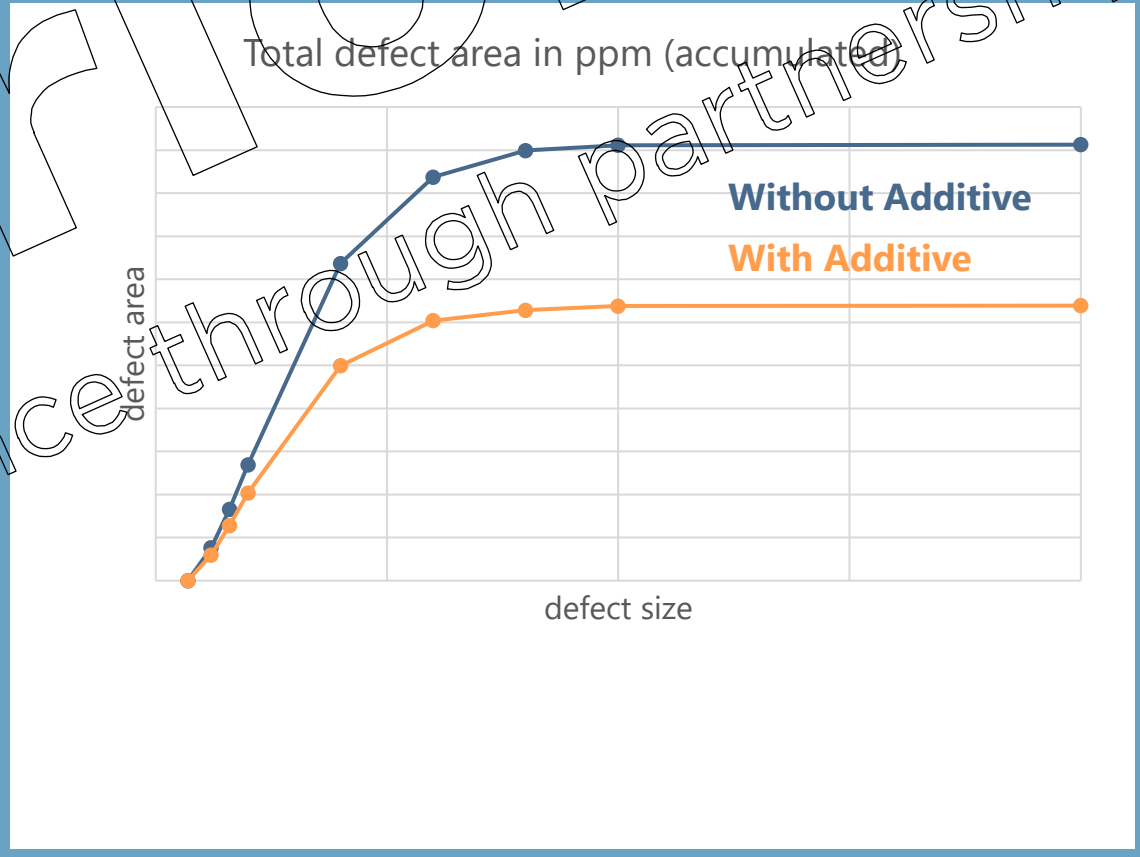
Additivation

Supermarket film





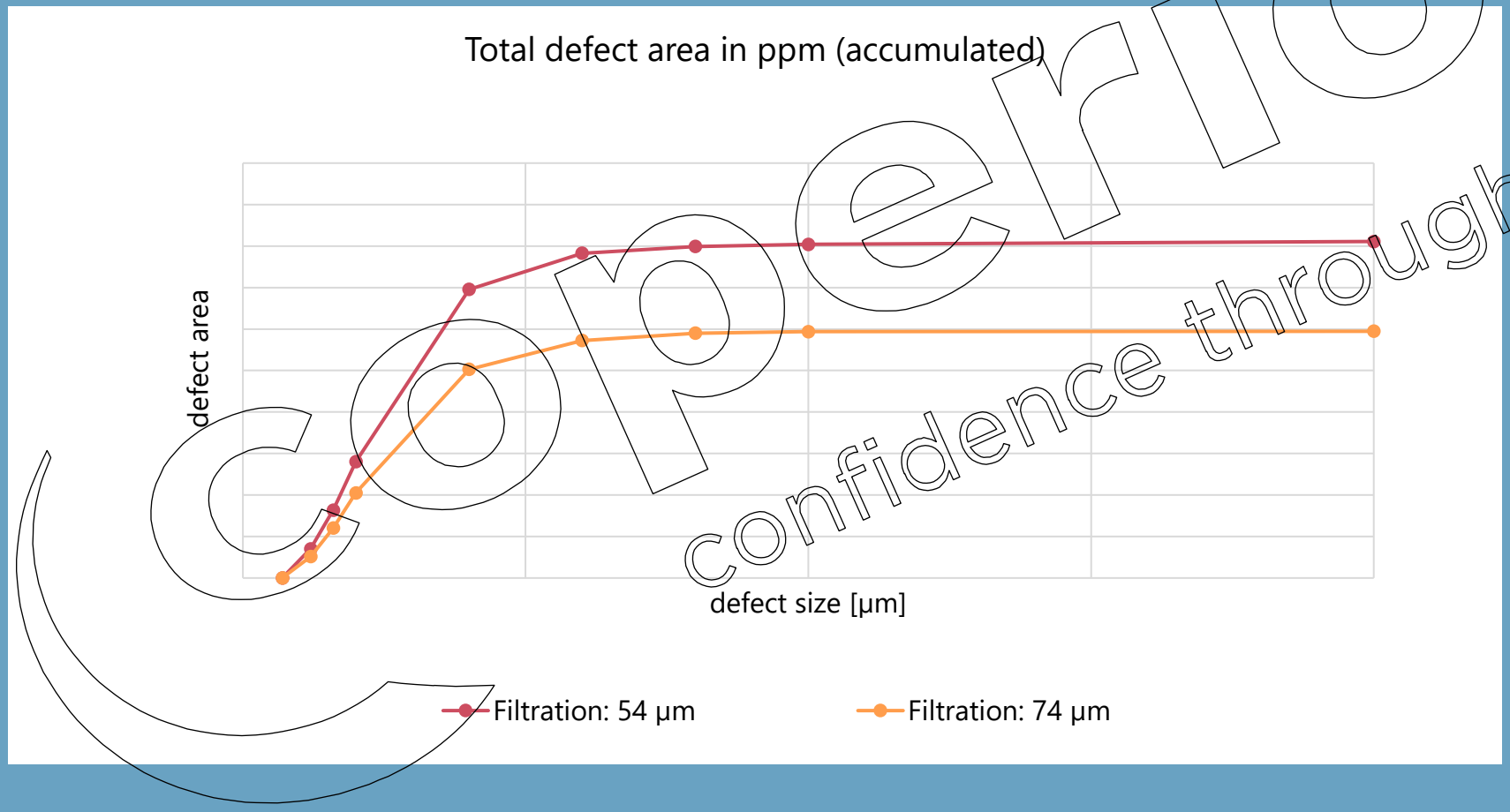
Postconsumer film



Focus on: QUALITY

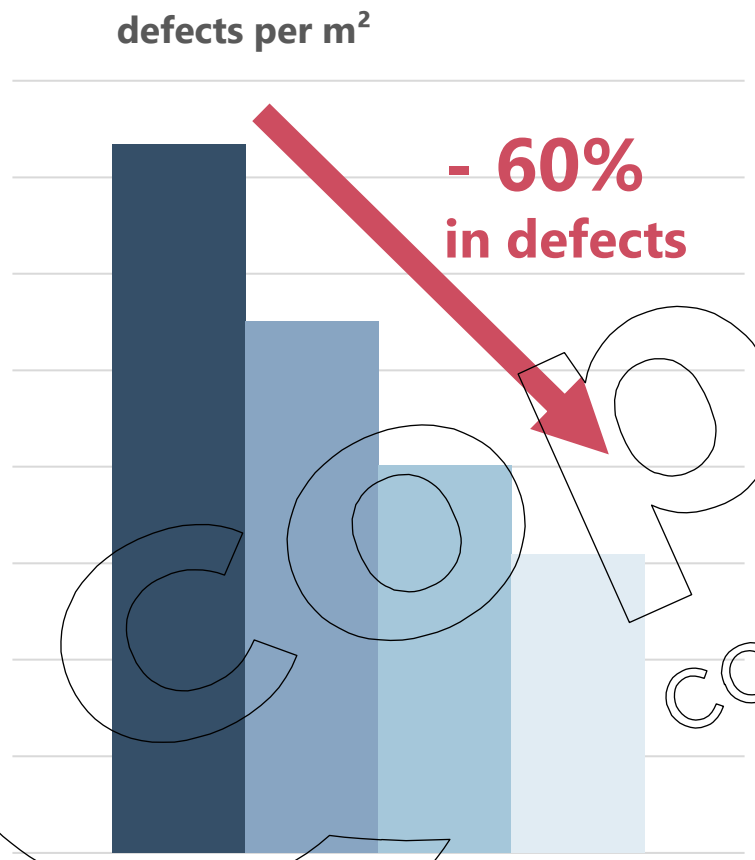
Filter Fineness

Supermarket film



Focus on: QUALITY

Filtration + Additivation



Benchmark single screw, 60µm filtration

Twin screw, 54µm filtration - Process parameters set to keep shear low, High pressure drop at filter (95bars) due to fine filtration

Same settings at extruder like (2)
Coarser filtration 74µm – lower pressure drop (45bars)

Same settings at extruder like (3).
Addition of Antioxidants

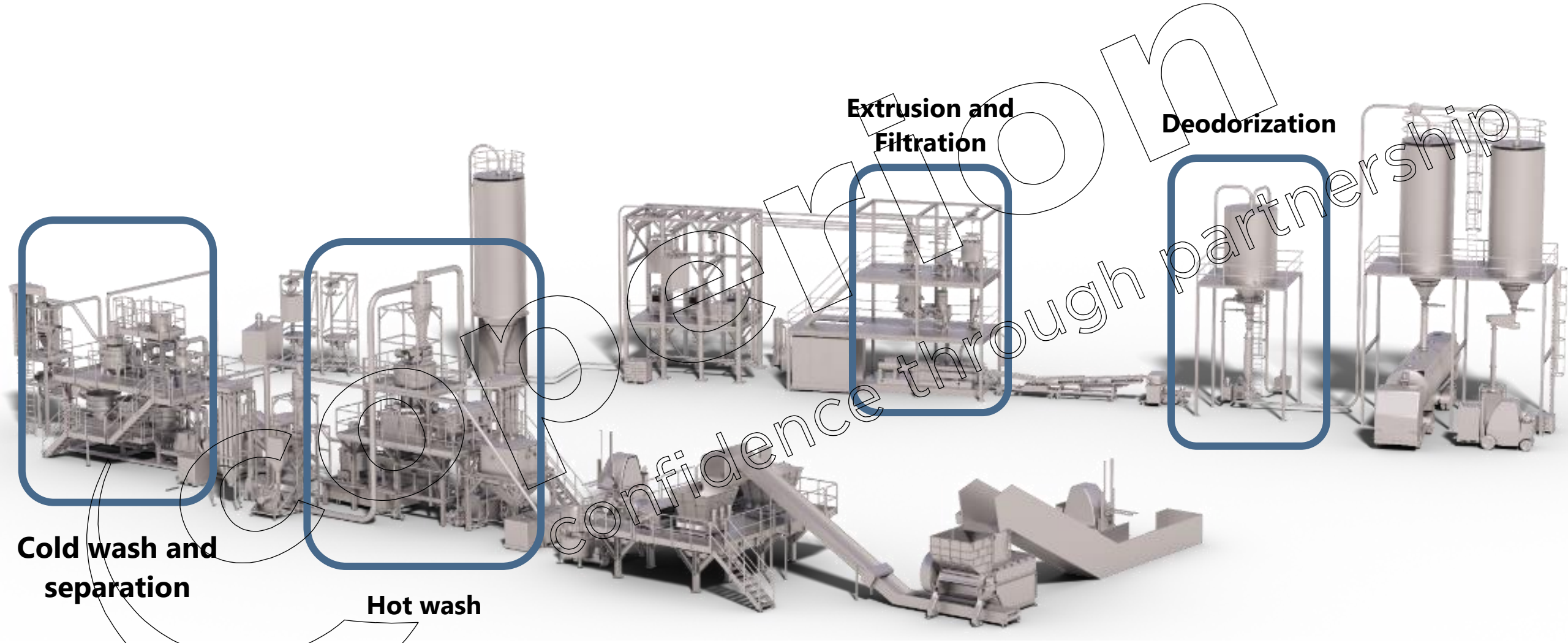
Focus on: QUALITY

Shear

Reference – single screw

Best settings twin screw

Challenges for film recycling



Challenges for film recycling

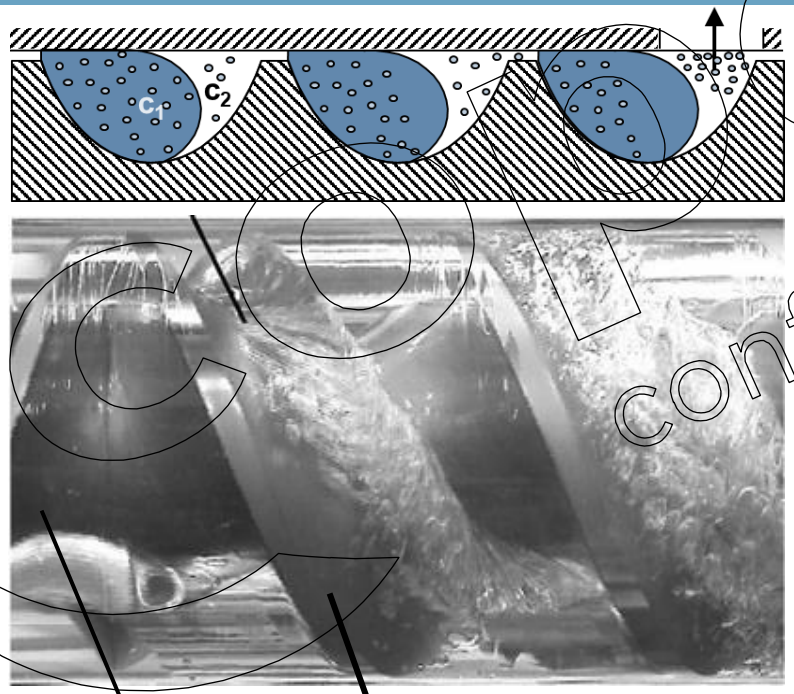
Deodorization

Focus on: QUALITY

Degassing and Deodorization

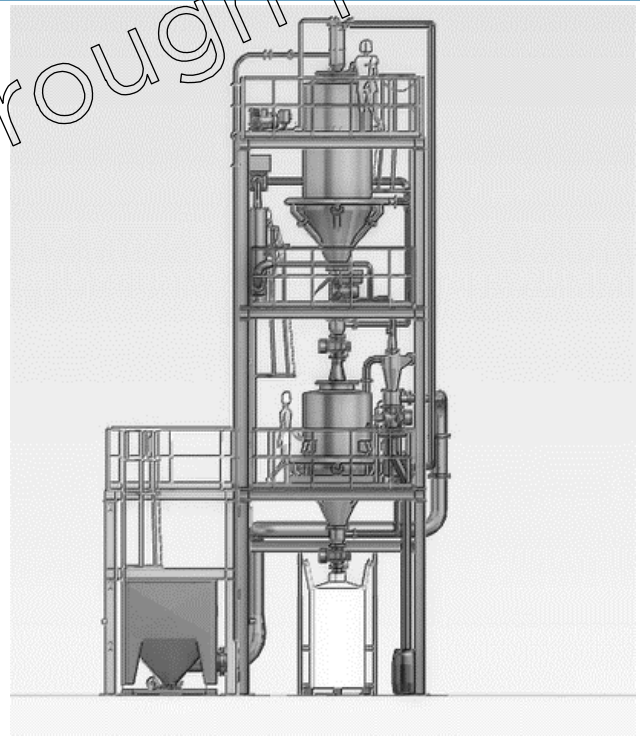
Degassing inside the twin screw extruder

- Degassing above melting temperature in the surface layers
- High surface renewal due to melt reallocation



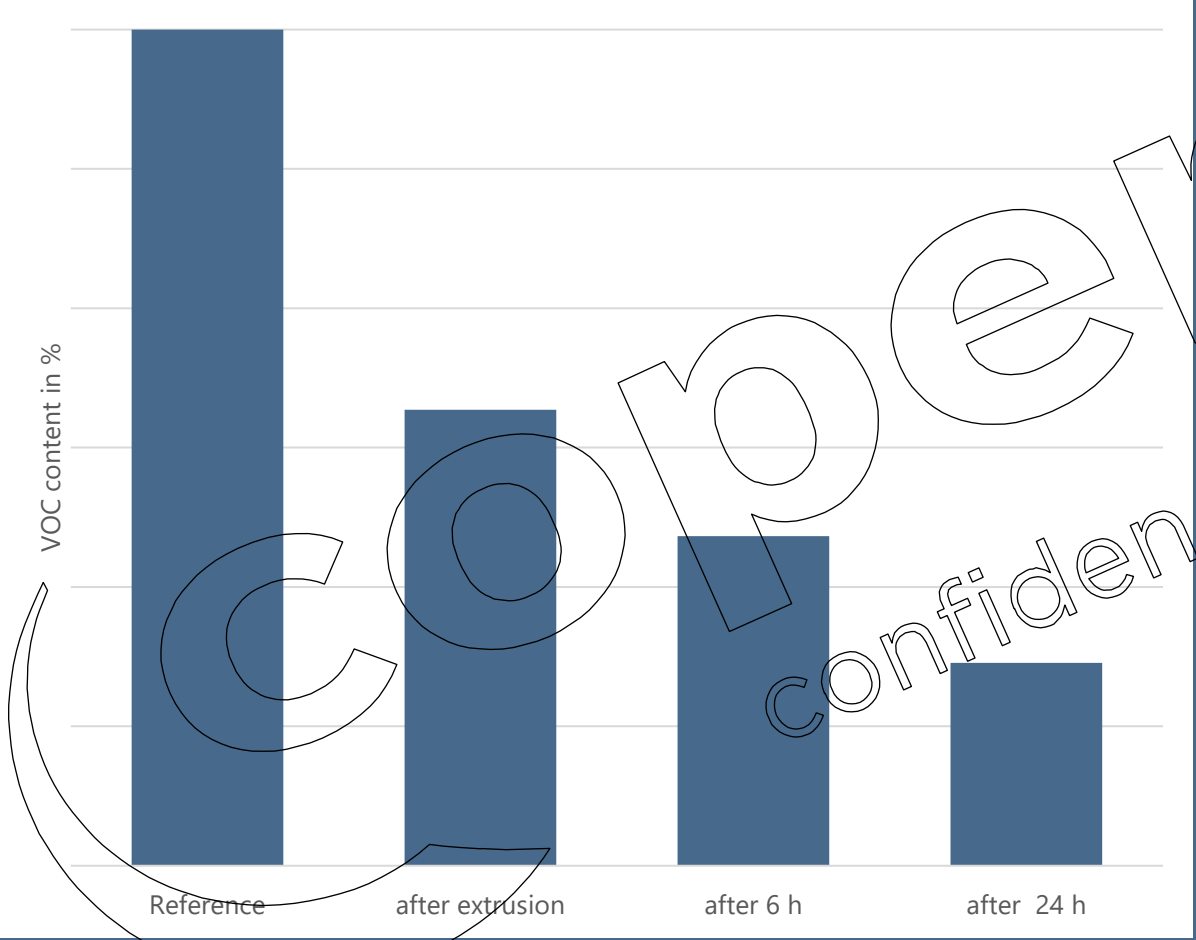
Deodorization in the degassing silo

- Degassing below melt temperatures
- Residence time adjustable to requirements



Focus on: QUALITY

Degassing and Deodorization



Volatile organic compound (VOC), gas chromotography according to VDA 277

Reduction of volatile organic content by degassing in the twin screw extruder

→ improvement by > **25%**

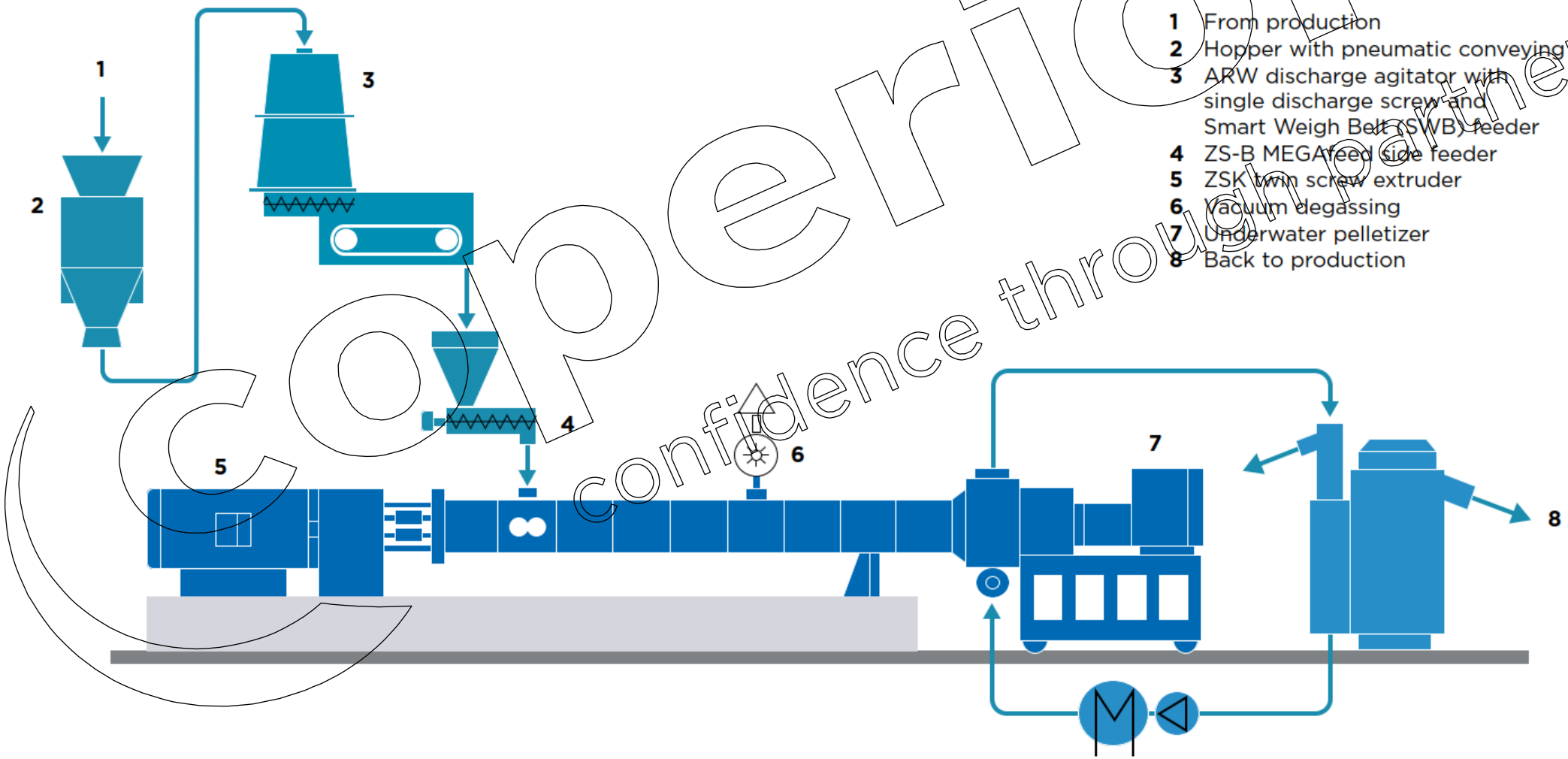
Further reduction of VOCs with the help of deodorization silo

→ Total reduction of almost **50%** compared to refence

→ **Combination leads to best results**

Focus on: HANDLING

Typical extruder set-up for film recycling



1 From production
2 Hopper with pneumatic conveying
3 ARW discharge agitator with single discharge screw and Smart Weigh Belt (SWB) feeder
4 ZS-B MEGAfeed side feeder
5 ZSK twin screw extruder
6 Vacuum degassing
7 Underwater pelletizer
8 Back to production

Focus on: HANDLING

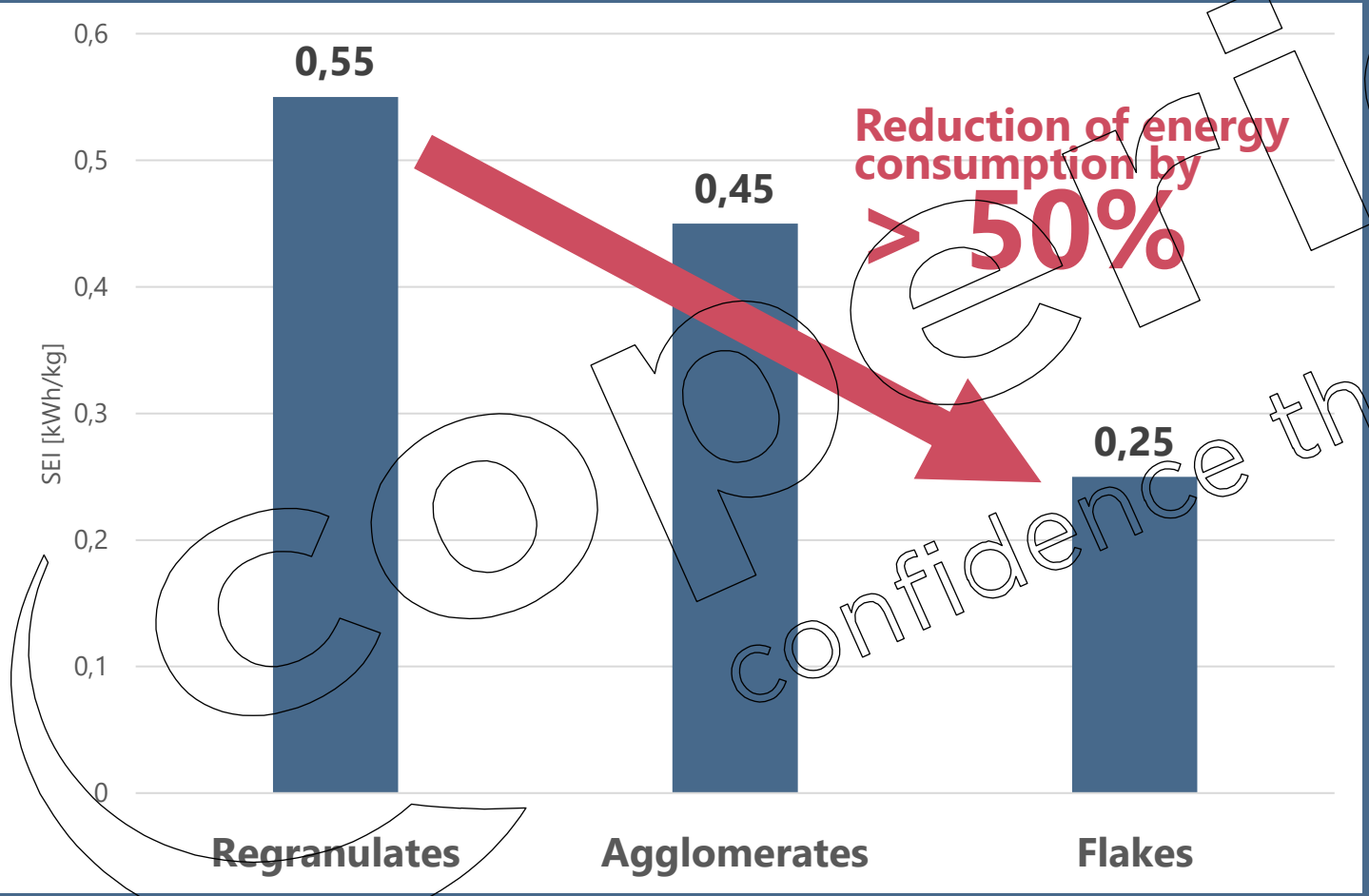
Feed Intake

Typically, it can be challenging to feed film flakes into a twin screw extruder, due the low bulk density.
Three different possibilities to utilize the twin screw extruder

Regranulates	Agglomerates	Flakes
• Bulk density ~500-600 kg/m³ • Requires two extruders • Highest energy input (2 x melting) • High footprint	• Bulk density: ~ 200-400 kg/m³ • Requires two machines • High energy input • Low storage requirement if agglomerated directly after washing	• Bulk density: 20-100 kg/m³ • Only one machine extruder required • Lowest energy input • Best if installed directly after washing (less storage and transportation issues)
		

Focus on: HANDLING

Feed Intake



Typically, it can be challenging to feed film flakes into a twin screw extruder, due the low bulk density. Three different possibilities to utilize the twin screw extruder

Summary

1. In order to improve the quality of film recyclates the whole process needs to be taken into consideration
2. Improvement in product quality already starts at the sorting step
3. Within the washing process quality can be improved by using a hydrocyclone for better separation
4. Hot washing can improve the quality by removing adheseves from the film
5. Within the extrusion step filtration, additivation and shear is key for quality
6. Handling Flakes directly in the twin screw extruder is most economical

Thank you!

Marina Matta
Team Leader Process Technology – Recycling | Coperion


HERBOLD
MECKESHEIM
coperion

Appliction Deep Dive:
Twin Screw Extrusion and Polymetrix SSP Decontamination Technology for rPET

Sabine Schönfeld
Sales Manager Recycling | Coperion

Martin Müller
CEO I Polymetrix

Devendra Surana
Founder & Managing Director | Magpet Polymers private Ltd.

Coperion Recycling PET unique selling points

Improved quality

- Batch Hot Wash Design in combination with Hydrocyclone density separation
- Constant iV, minimal iV drop and improved b-value after extrusion

Reduced opex

- Very low energy consumption (approx. 0,11 kW/kg output material in wash plant)
- Complete water cleaning circuit (also for fresh water)
- Significant energy savings due to ideal operating conditions in the twin screw extruder
- Additives only in minimal quantities needed

High throughput

- Wash lines up to 6,5 t/h
- Reduction of fines due to gentle washing/ drying process → higher yield
- Standard extruder concepts for PET for up to 10 mt/h
- Scalable concepts

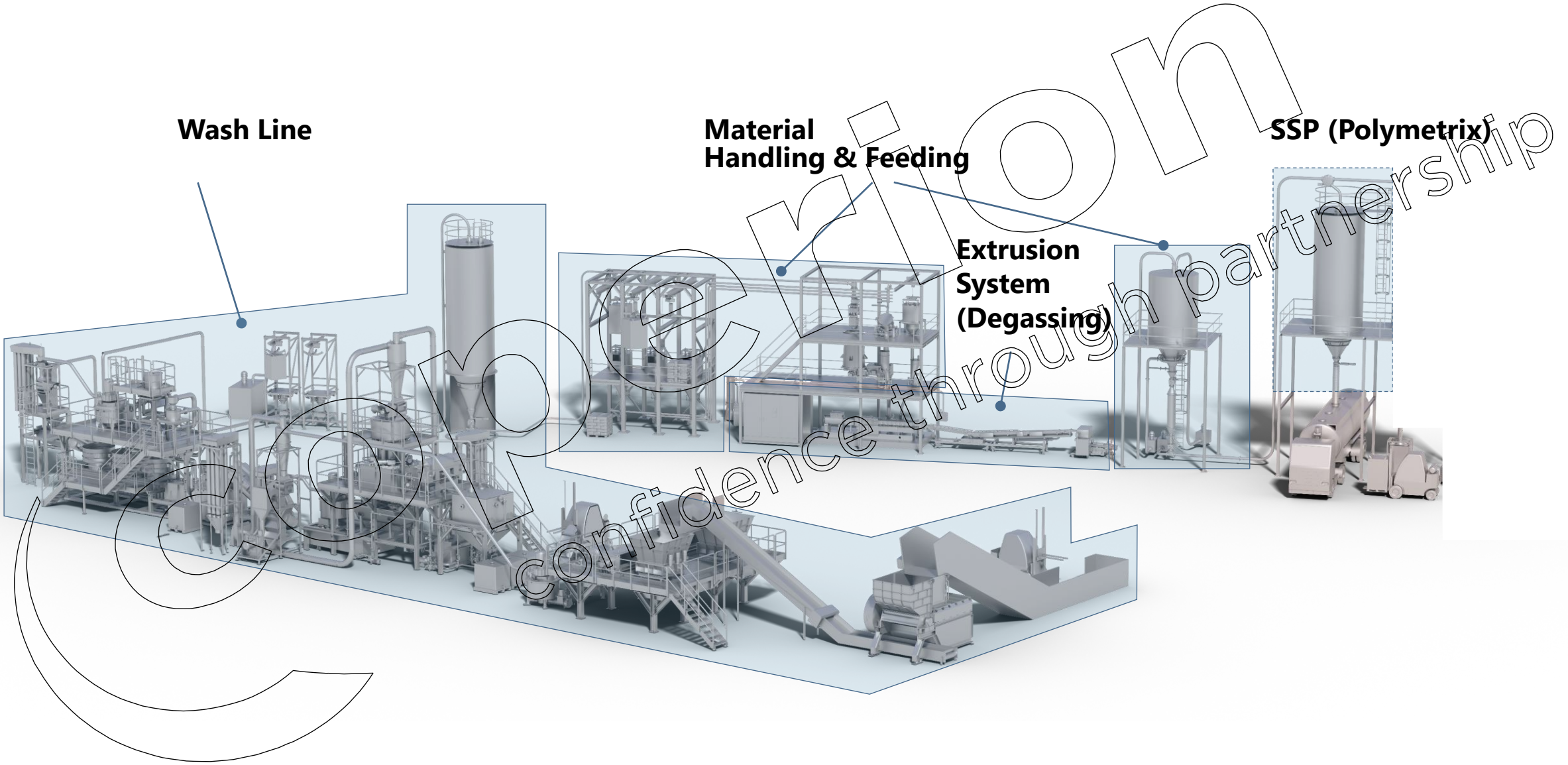
Optimized footprint

- Wash plant – compact area < 1000 m²
- Compact extruder design (no predrying)

Enhanced flexibility

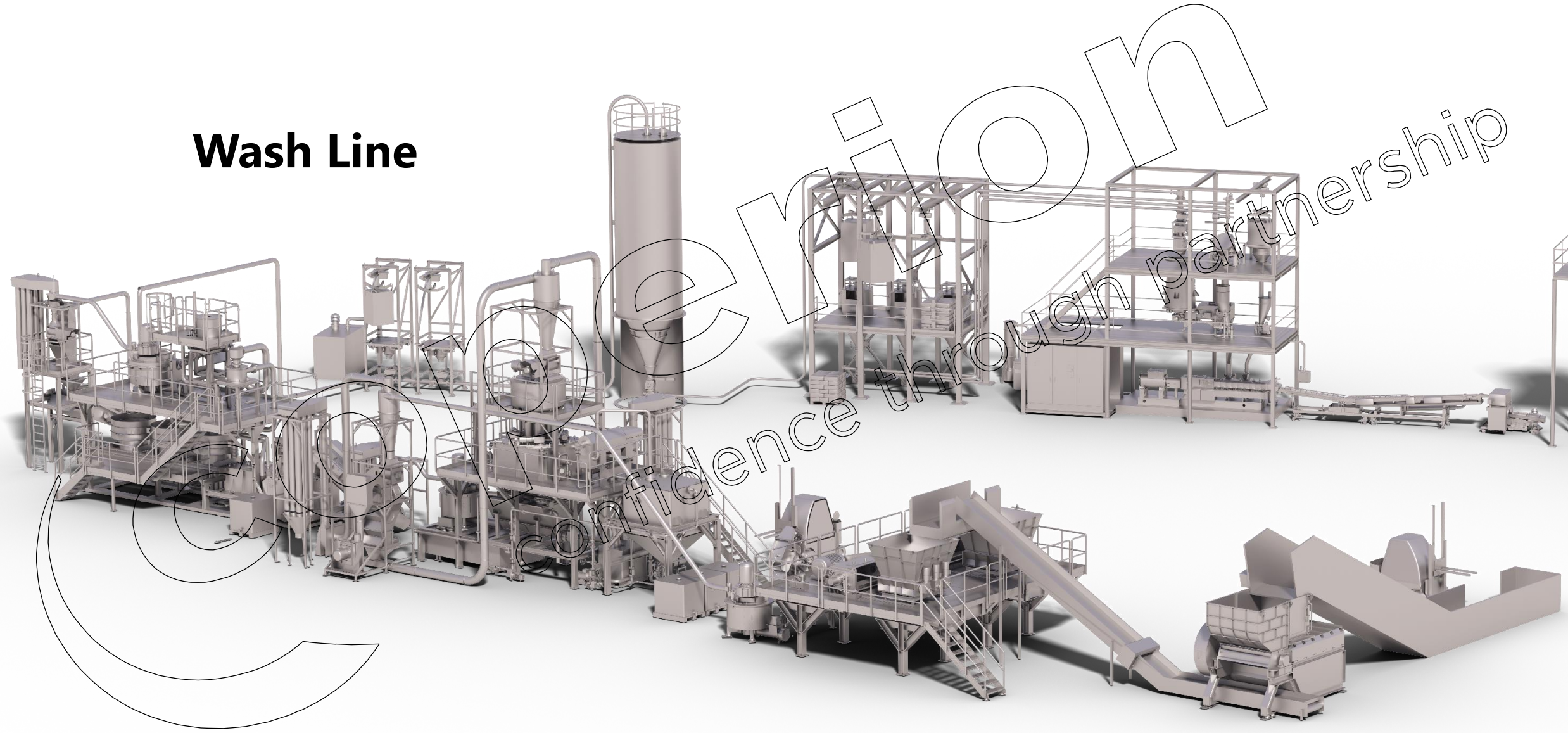
- Handling of difficult and diverse input materials
- Building bloc principle for wash line and extruder, adaptable to flexible design

Challenges for PET recycling



Challenges for PET recycling

Wash Line



PET Recycling: Washing Process

Hydrocyclone density separation:

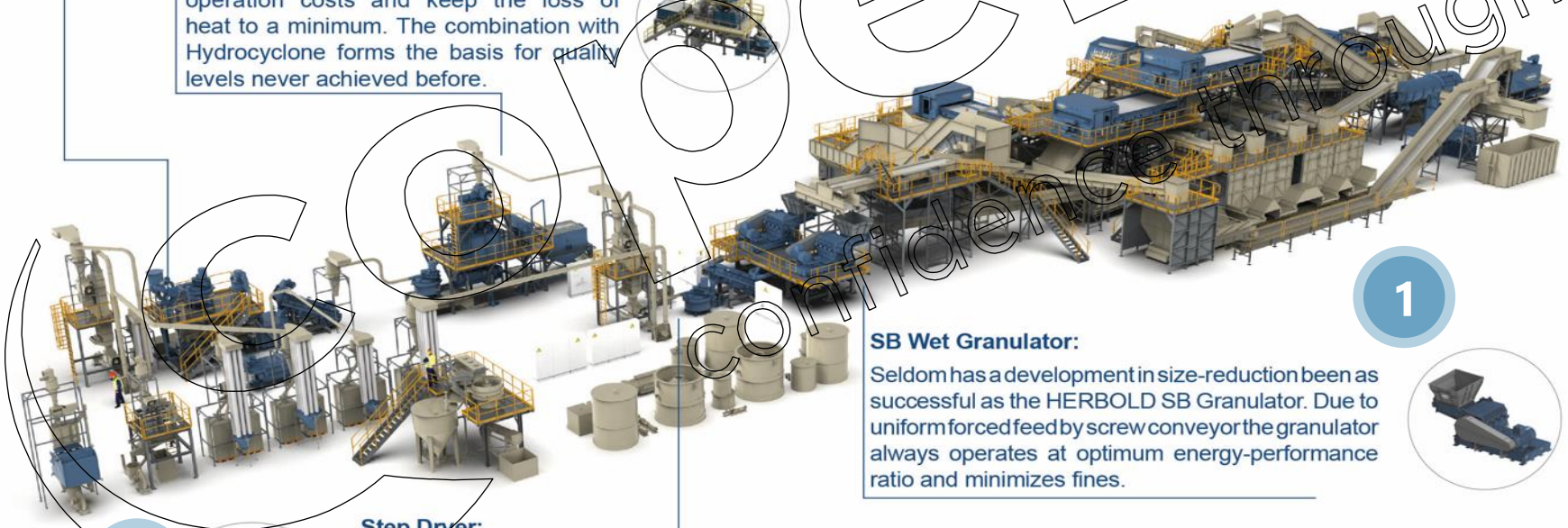
HERBOLD relies on density separation with Hydrocyclone. The separation efficiency is much higher compared to swim-sink tanks due to the usage of centrifugal forces. In addition the turbulence generates high friction and an additional washing effect.

4

3

Hot Wash Step:

Additional hot-water treatment reduces operation costs and keep the loss of heat to a minimum. The combination with Hydrocyclone forms the basis for quality levels never achieved before.



1

SB Wet Granulator:

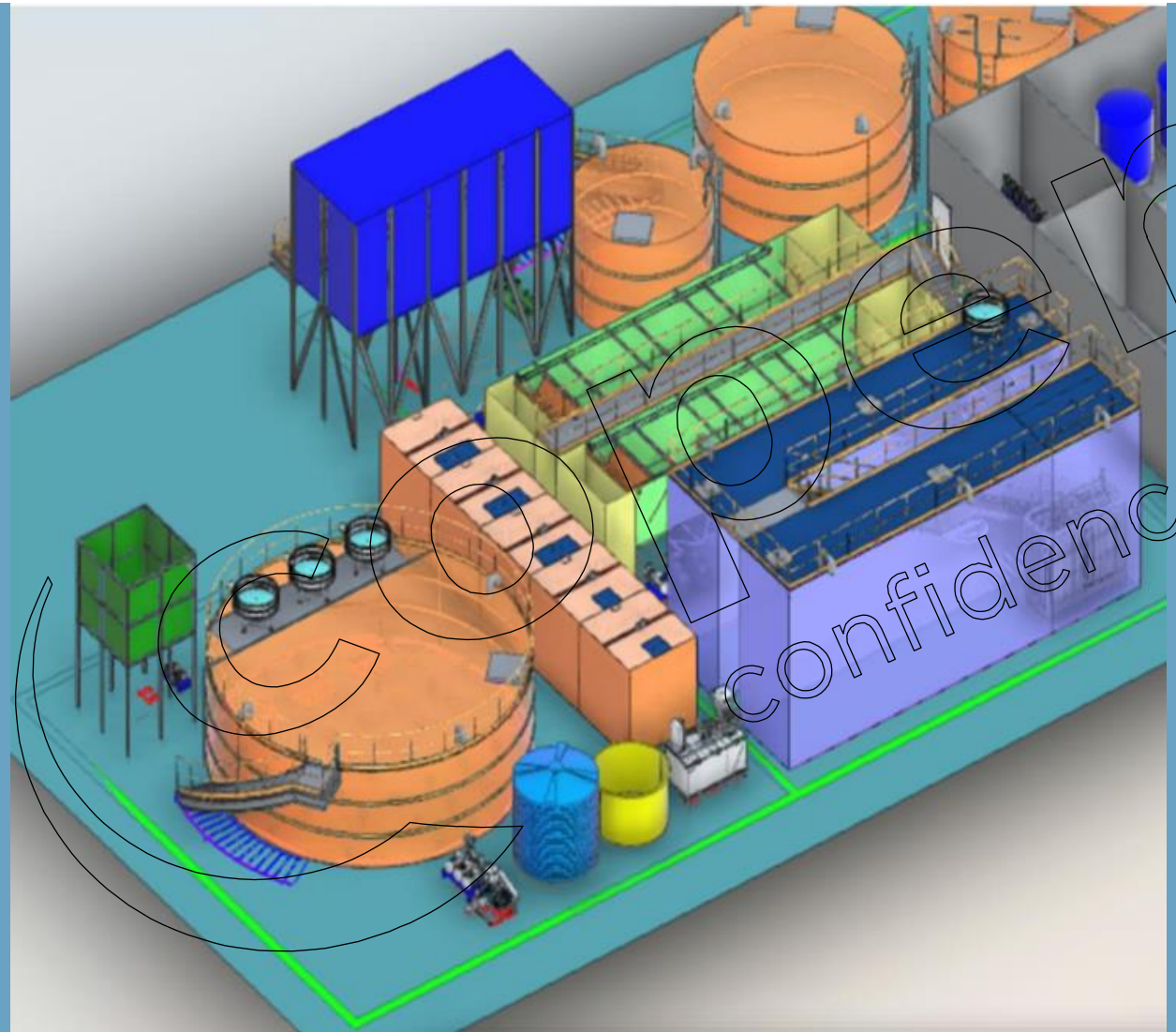
Seldom has a development in size-reduction been as successful as the HERBOLD SB Granulator. Due to uniform forced feed by screw conveyor the granulator always operates at optimum energy-performance ratio and minimizes fines.

2

Step Dryer:

Gentle drying of particularly brittle plastics and PET-Flakes with least material loss caused by fines.

PET Recycling: Water Treatment



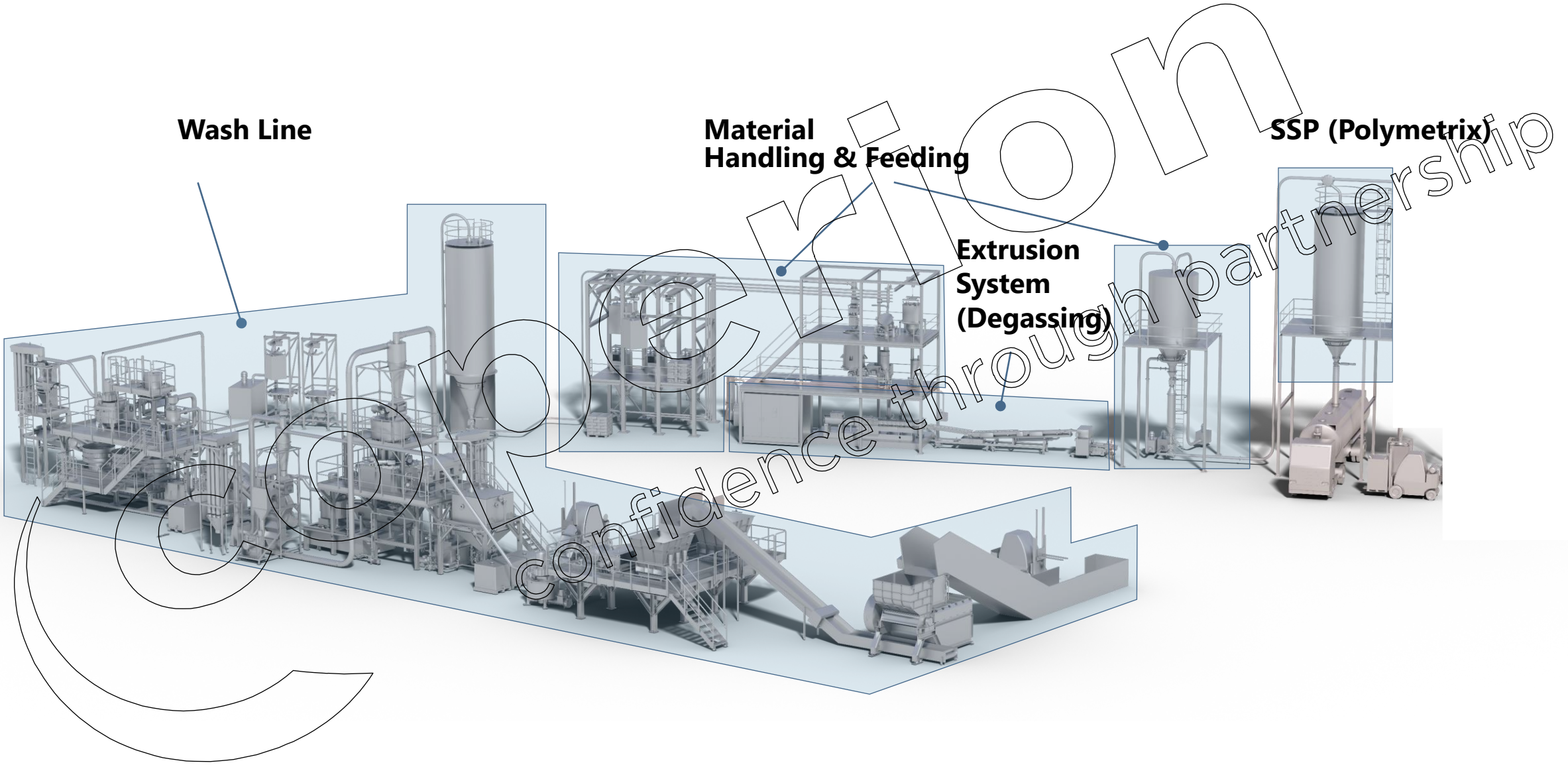
Highest purity level of water by mechanical, chemical, biological and reverse osmosis treatment

→ **Increased lifetime of machines and parts**

Treatment of total process as well as fresh water

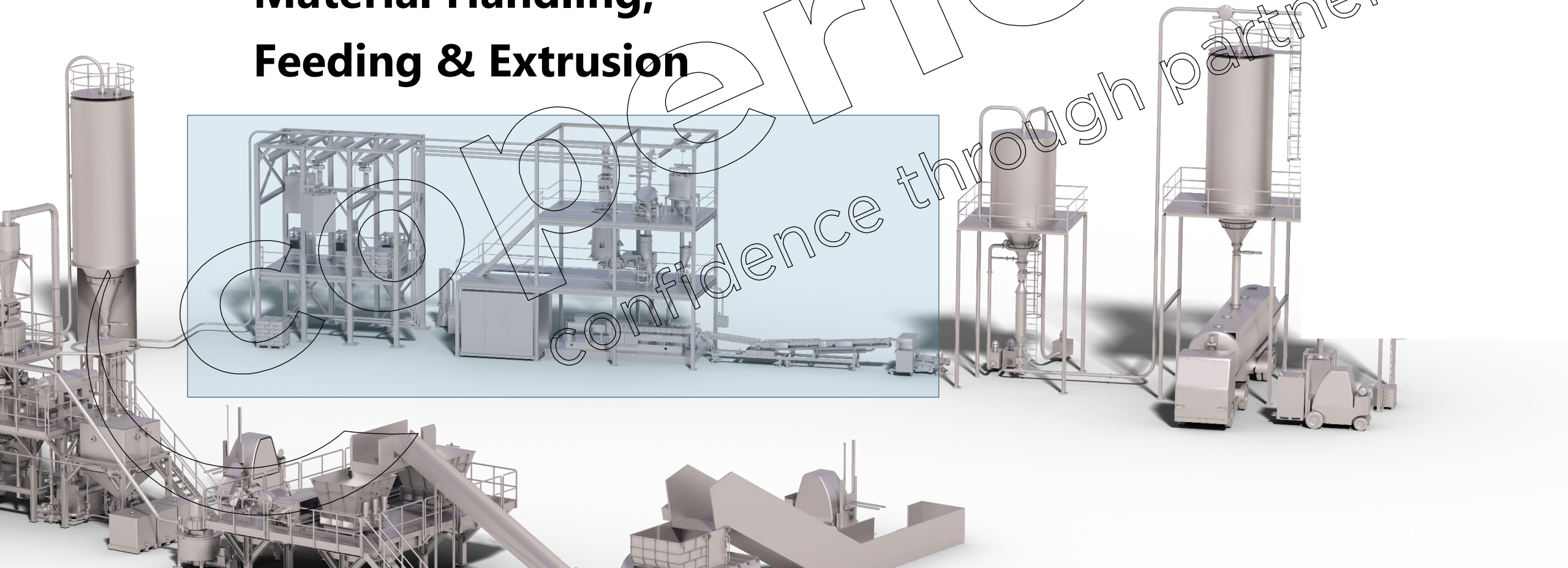
→ **Reduced fresh water costs**

Challenges for PET recycling



Challenges for PET recycling

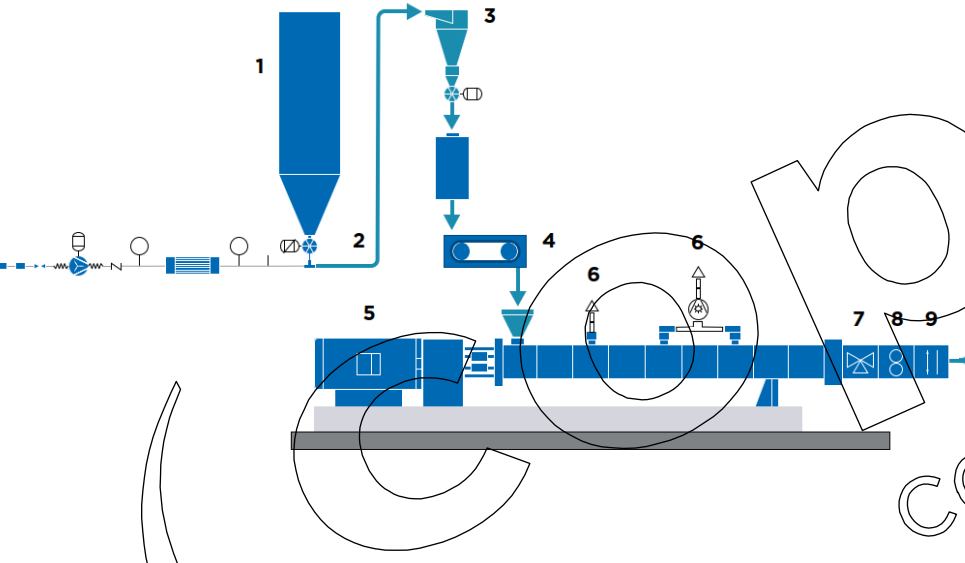
Material Handling,
Feeding & Extrusion

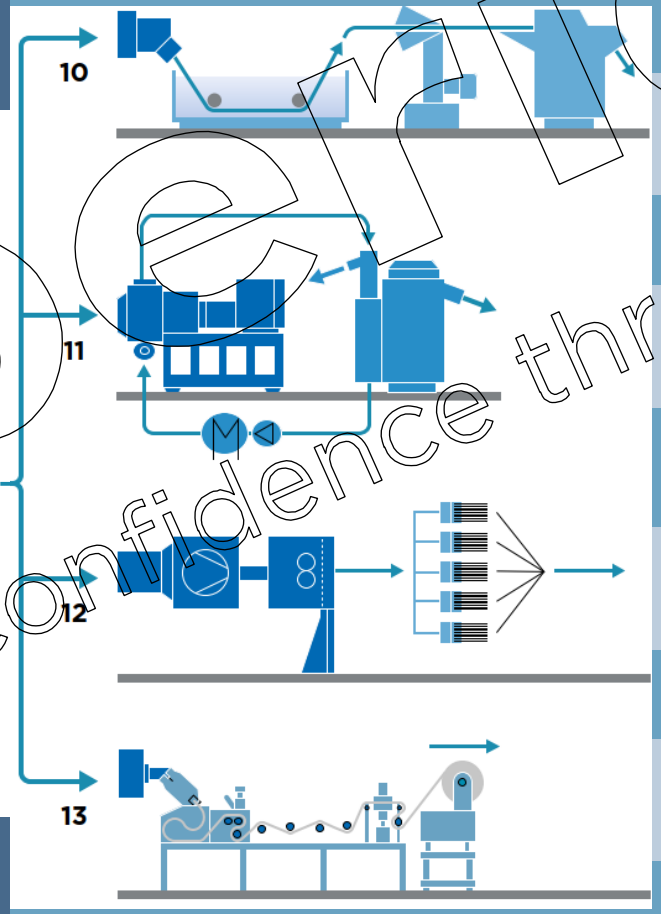


Mechanical recycling of PET

Possible downstream equipment - 30 years experience independent of the final application

Same extruder design for all final applications





Strand pelletizing (bottle-to-bottle)

Underwater pelletizing (bottle-to-bottle)

Fiber production (bottle-to fibre)

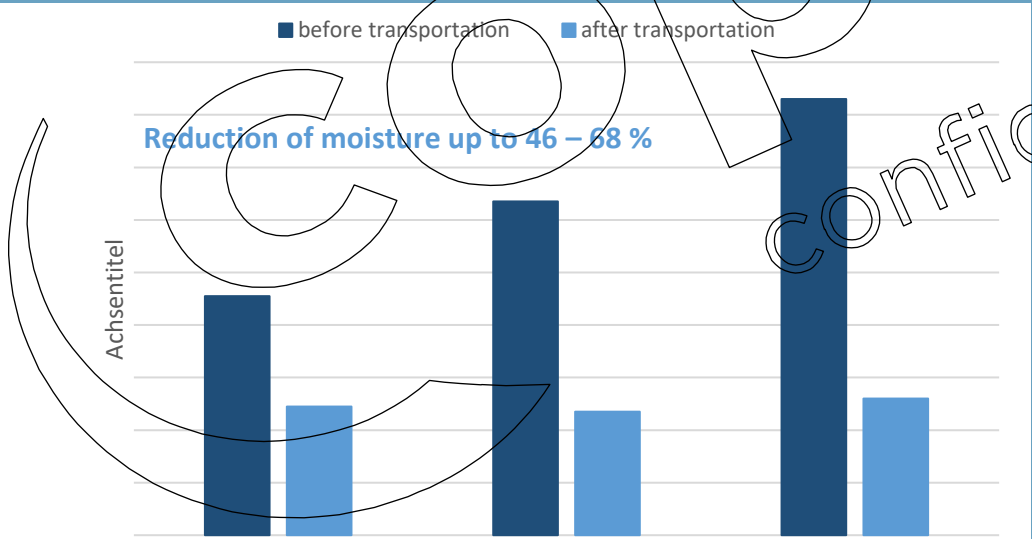
Sheet production (bottle-to-sheet)

Mechanical recycling of PET

Challenge: high residual moisture > 1 %

FLUIDLIFT Ecodry

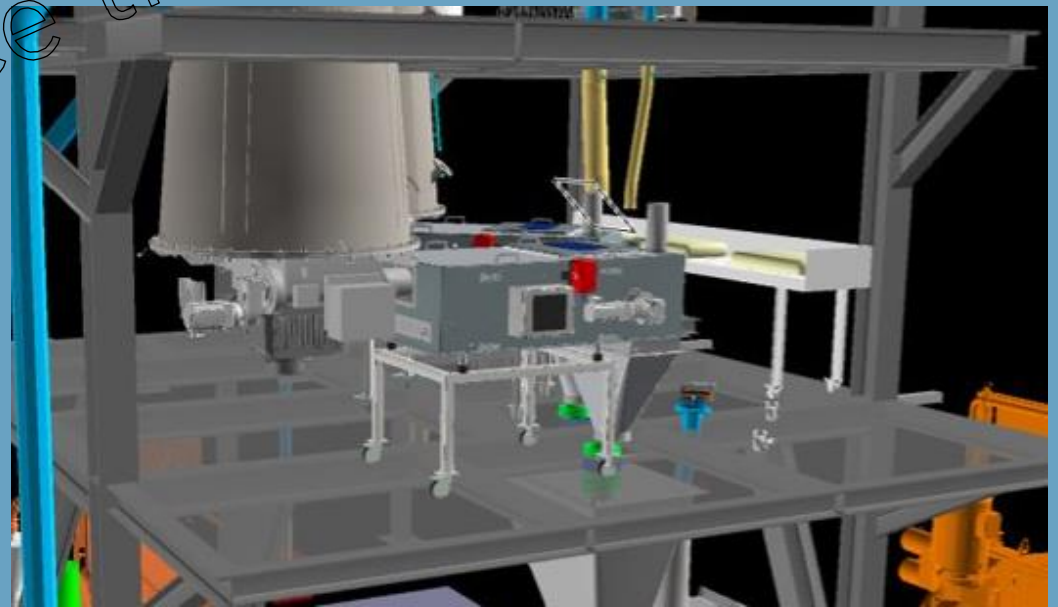
- Reduction of energy consumption
- Reduction of vacuum unit and cost
- Lower iV drop in the extruder (increase in quality)



Challenge: irregular shapes and fluctuations in bulk density

Silo Discharge ARW and Smart Weigh Belt Feeder

- Cost reduction of steel structure
- No bridging problems
- Optimized compensation for fluctuations in bulk density (constant feeding for a stable process – additives needed only in minimal quantity)

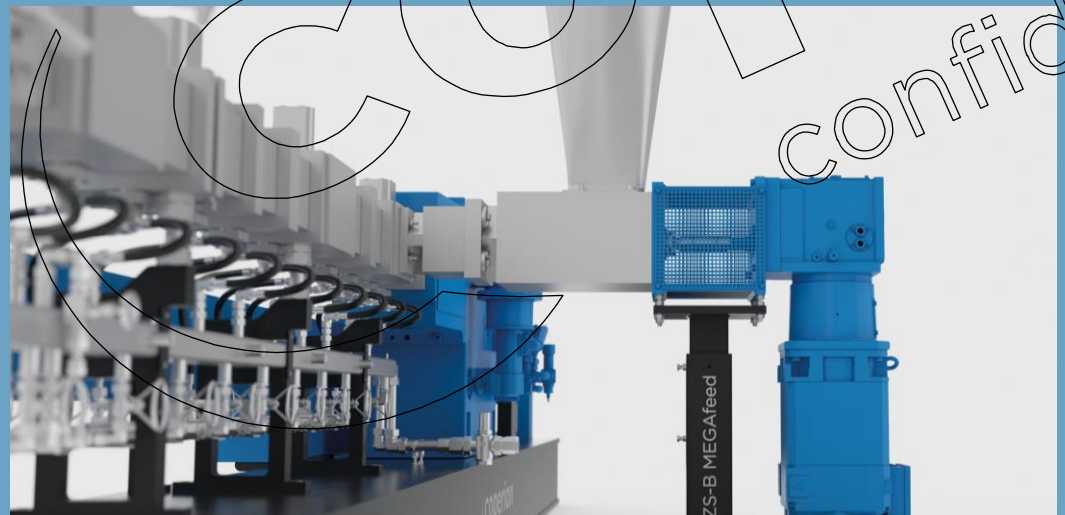


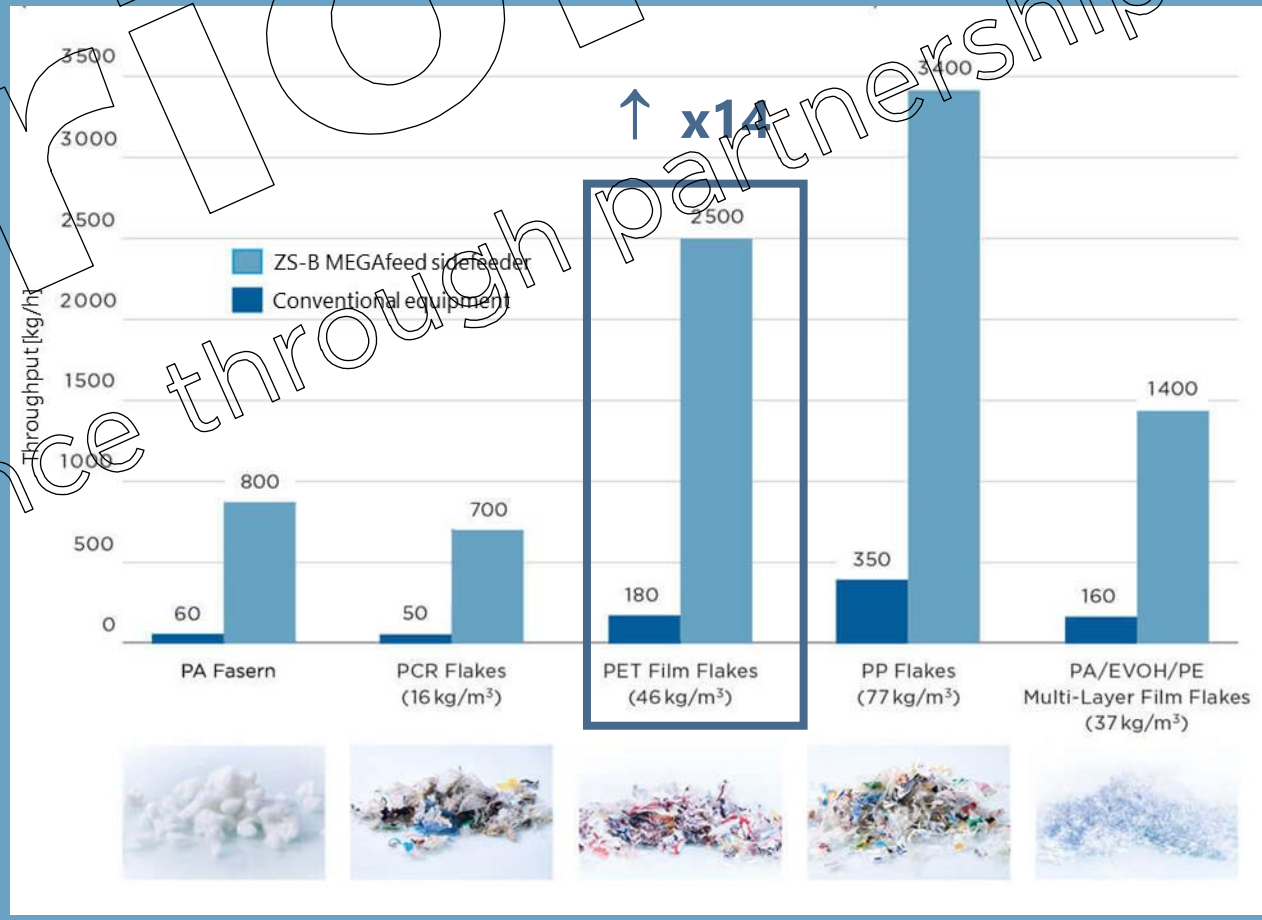
Mechanical Recycling of PET

Challenge: low bulk density of film and bottle flakes

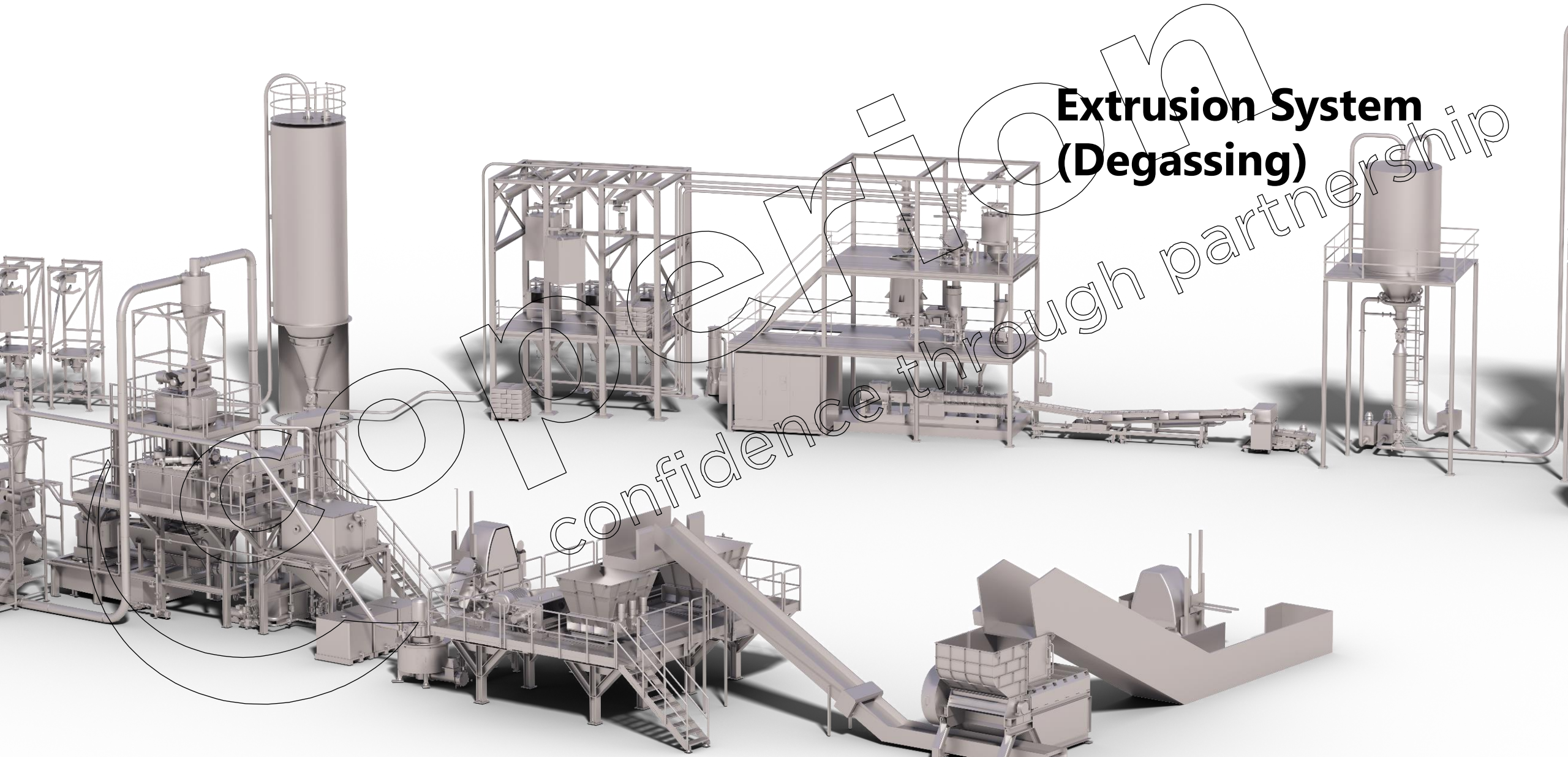
ZS-B MEGAfeed side feeder

- Reduction of feed intake limitation / increase in feed capacity
- Smaller extruder size possible - more economical recycling of light flakes
- Can be retrofitted to existing systems (modular plant design)



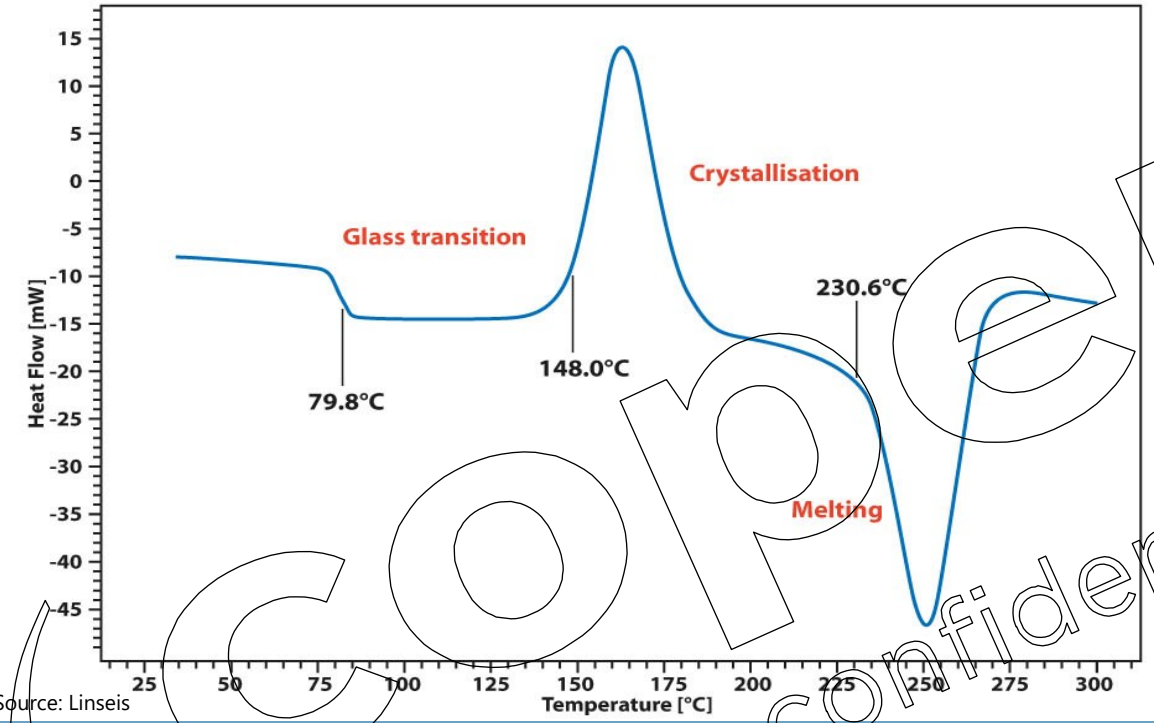


Challenges for PET recycling



Mechanical Recycling of PET

Challenge: State of the art moisture removal



Source: Linseis

ZSK twin screw without pre-treatment

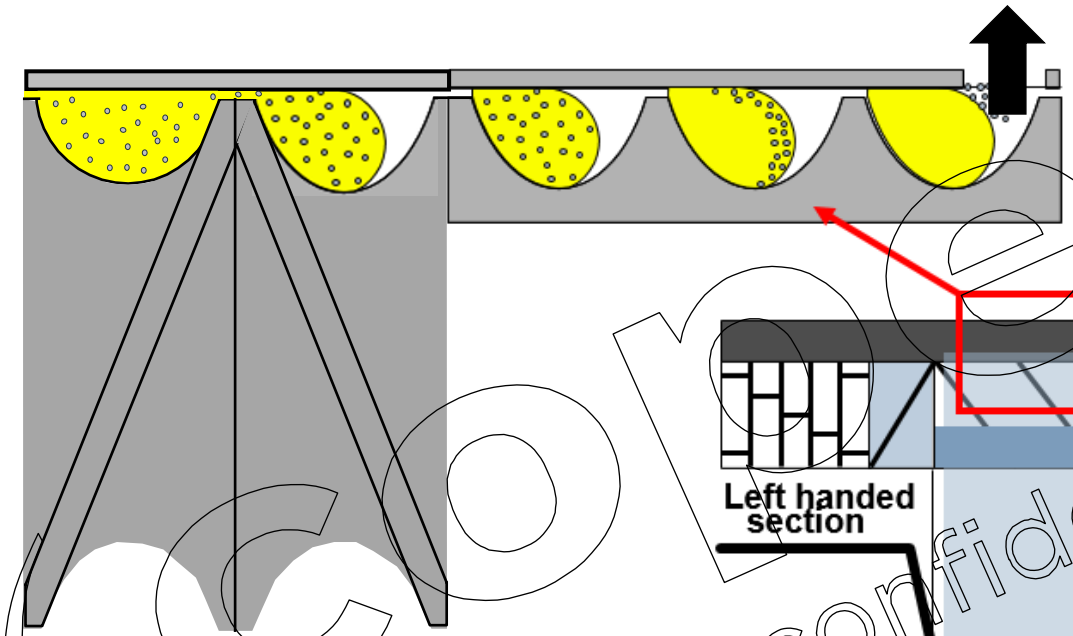
Single screw extruder with pre-drying

	Twin Screw	State of the art
Predrying	Optional, surface moisture	Obligatory, inner moisture
Moisture after drying	Optional down to 4500 ppm	Obligatory to 200 ppm
Crystallization	Not required	Required

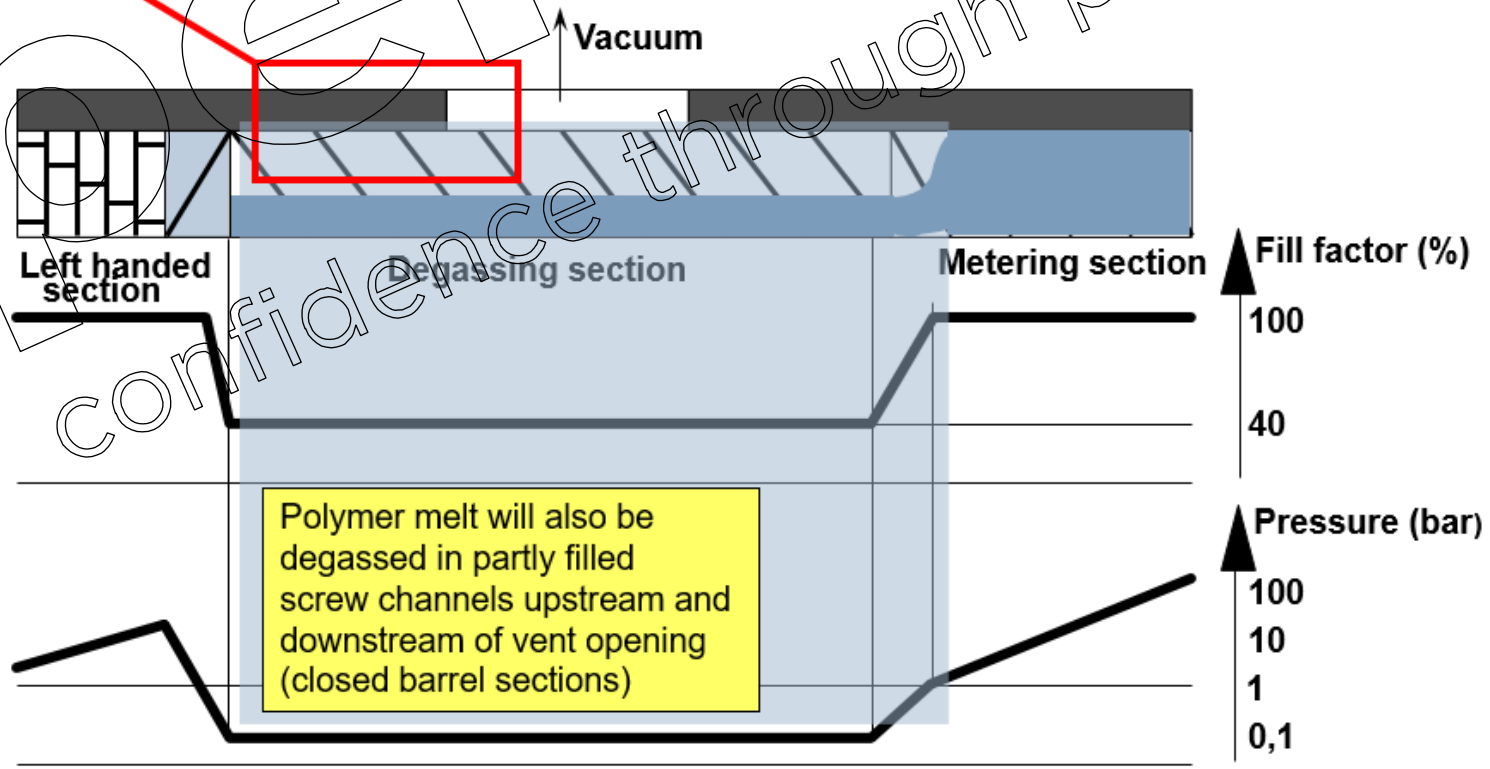
Moisture levels up to 1,5% on twin screw extruder, and still energy savings of 30-40%

Mechanical Recycling of PET

Principle of melt-based degassing



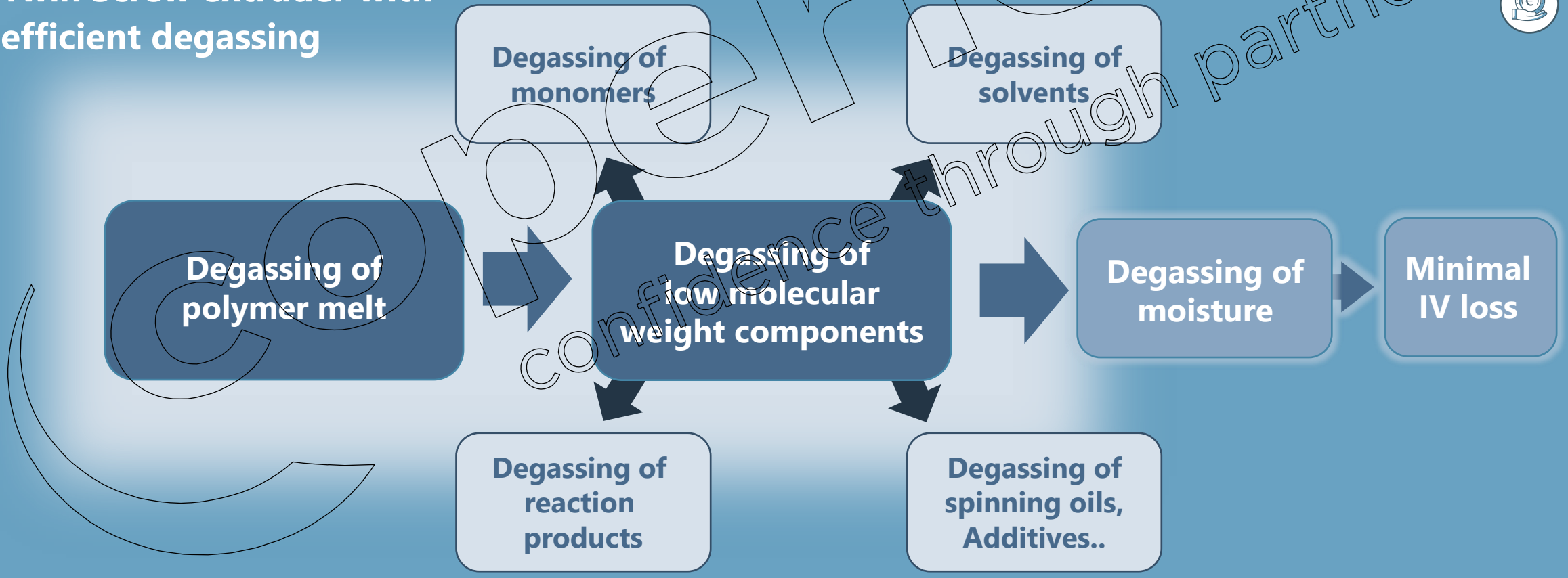
- **Gas contained in the melt must reach the surface of the melt layer**
- **Gas separation by diffusion**



Mechanical Recycling of PET

Degassing instead of pre-drying

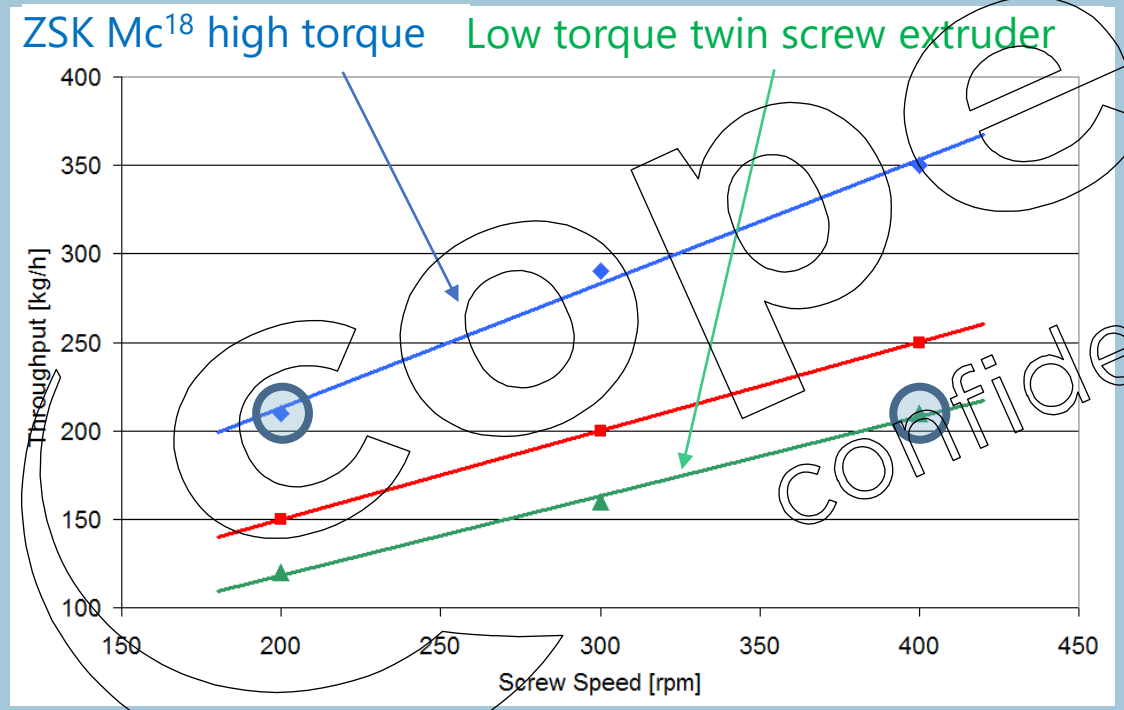
Quality will be better on a Twin Screw extruder with efficient degassing



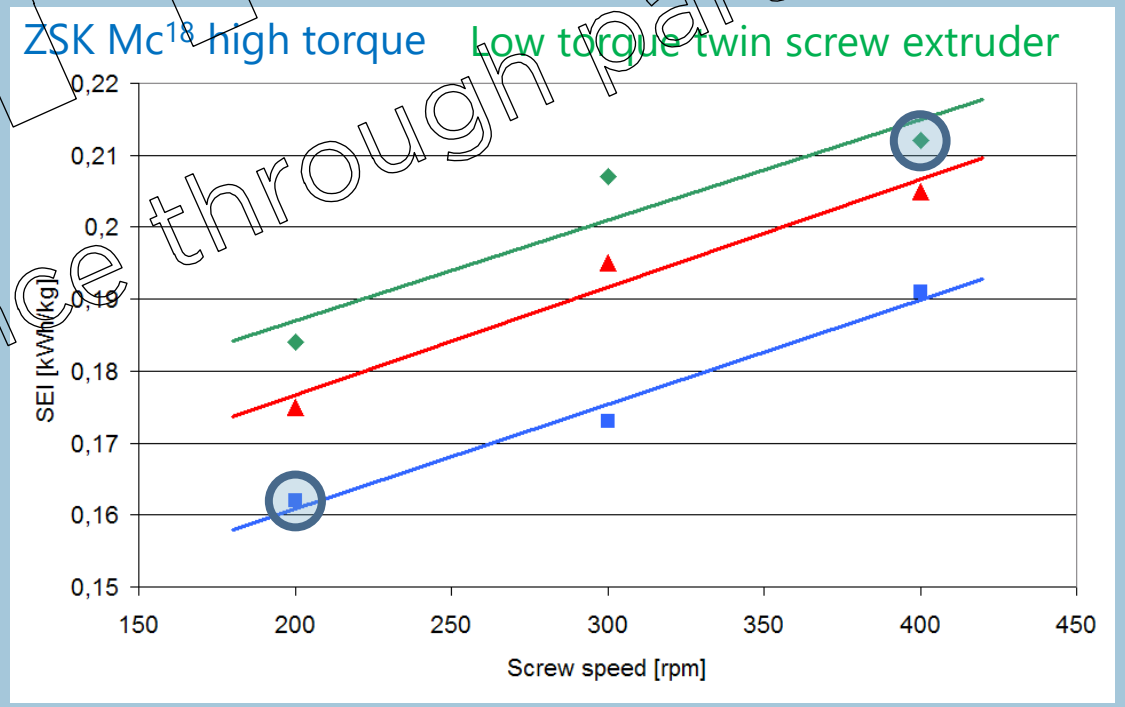
Melting and Degassing of PET – Pellets *(iV = 0,84 dl/g)*

Operating Parameters on ZSK 45 Mc^{18}

Throughput increase (up to 75%)



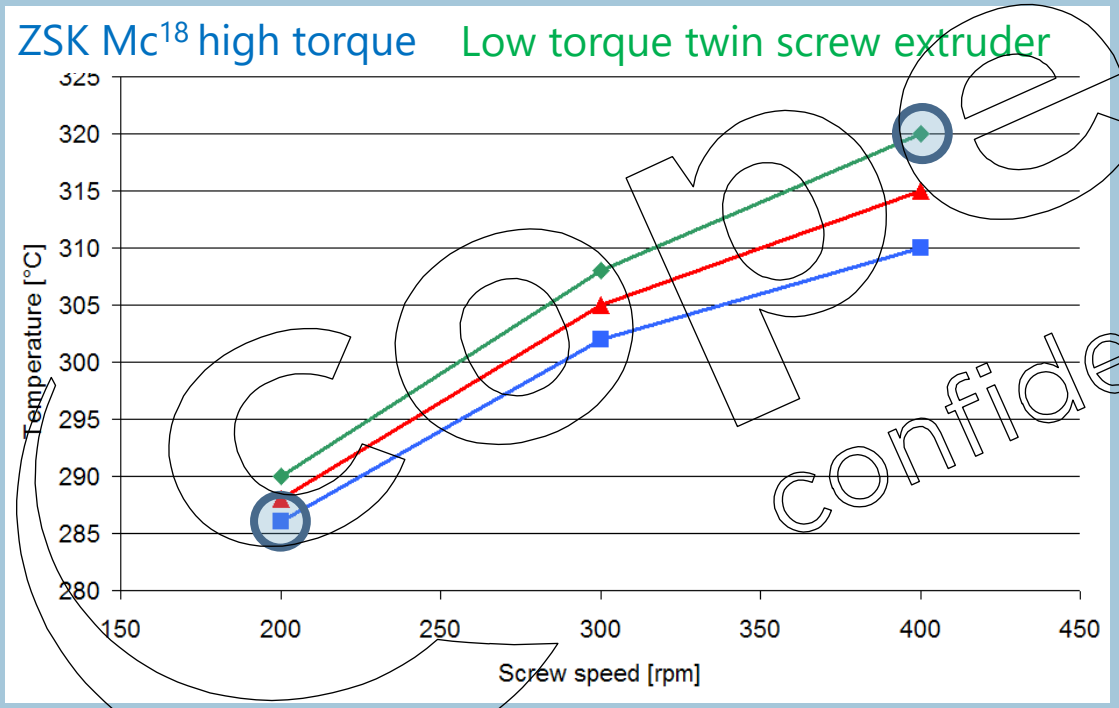
Energy savings up to 0,05 kWh/kg



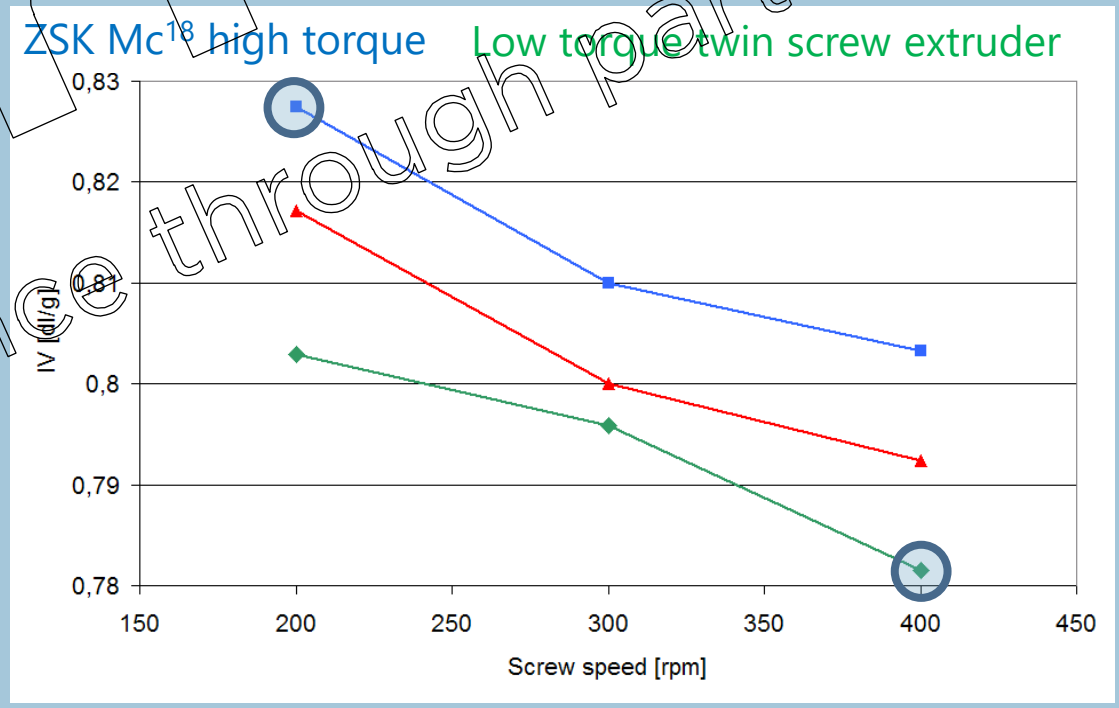
Melting and Degassing of PET – Pellets *(iV = 0,84 dl/g)*

Results for material temperature and viscosity

Melt Temperature reduction of up to 30°C

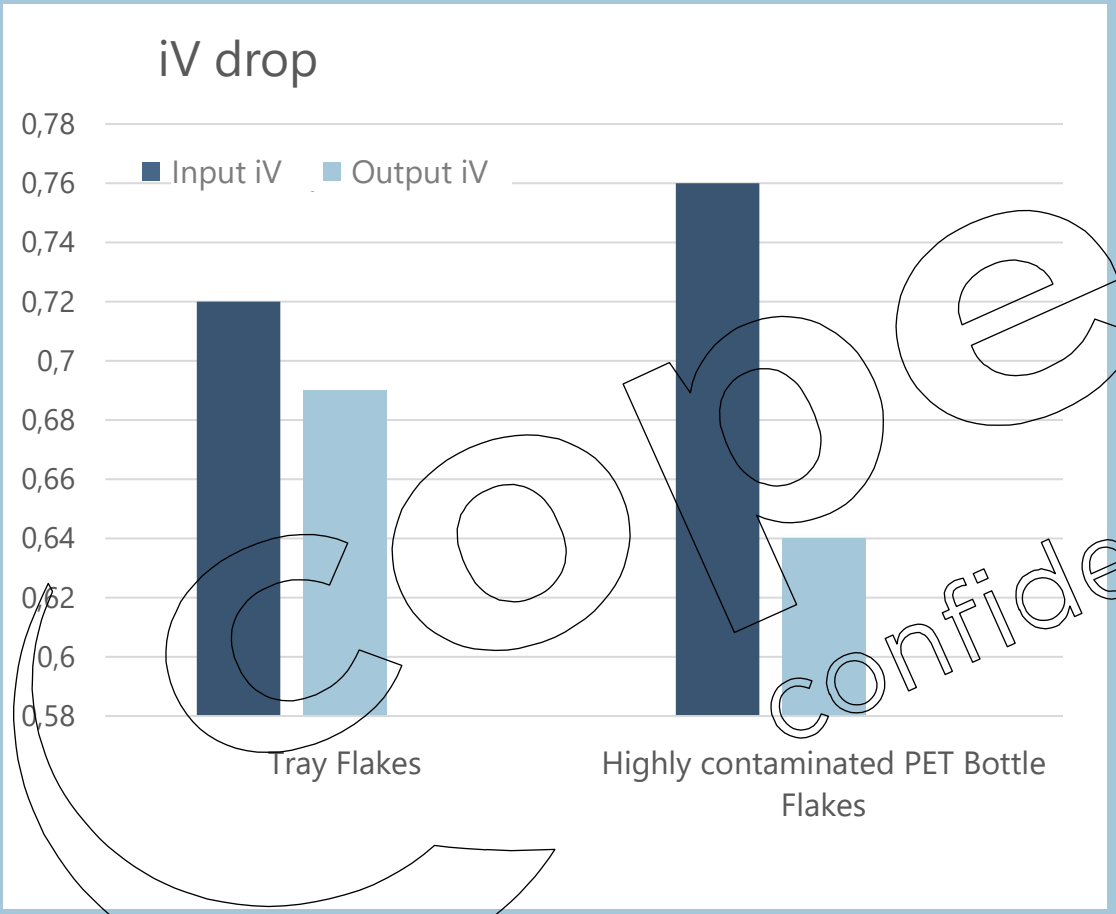


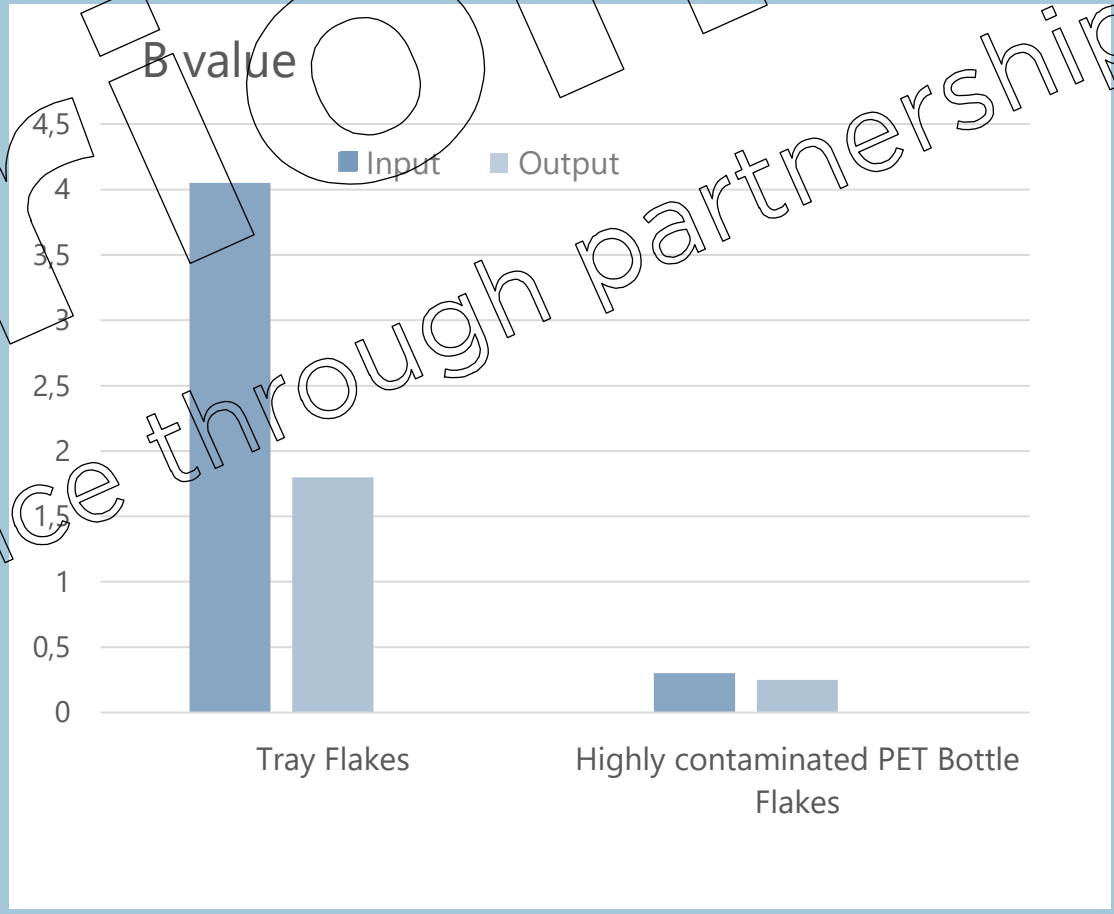
Less iV degradation at higher torque



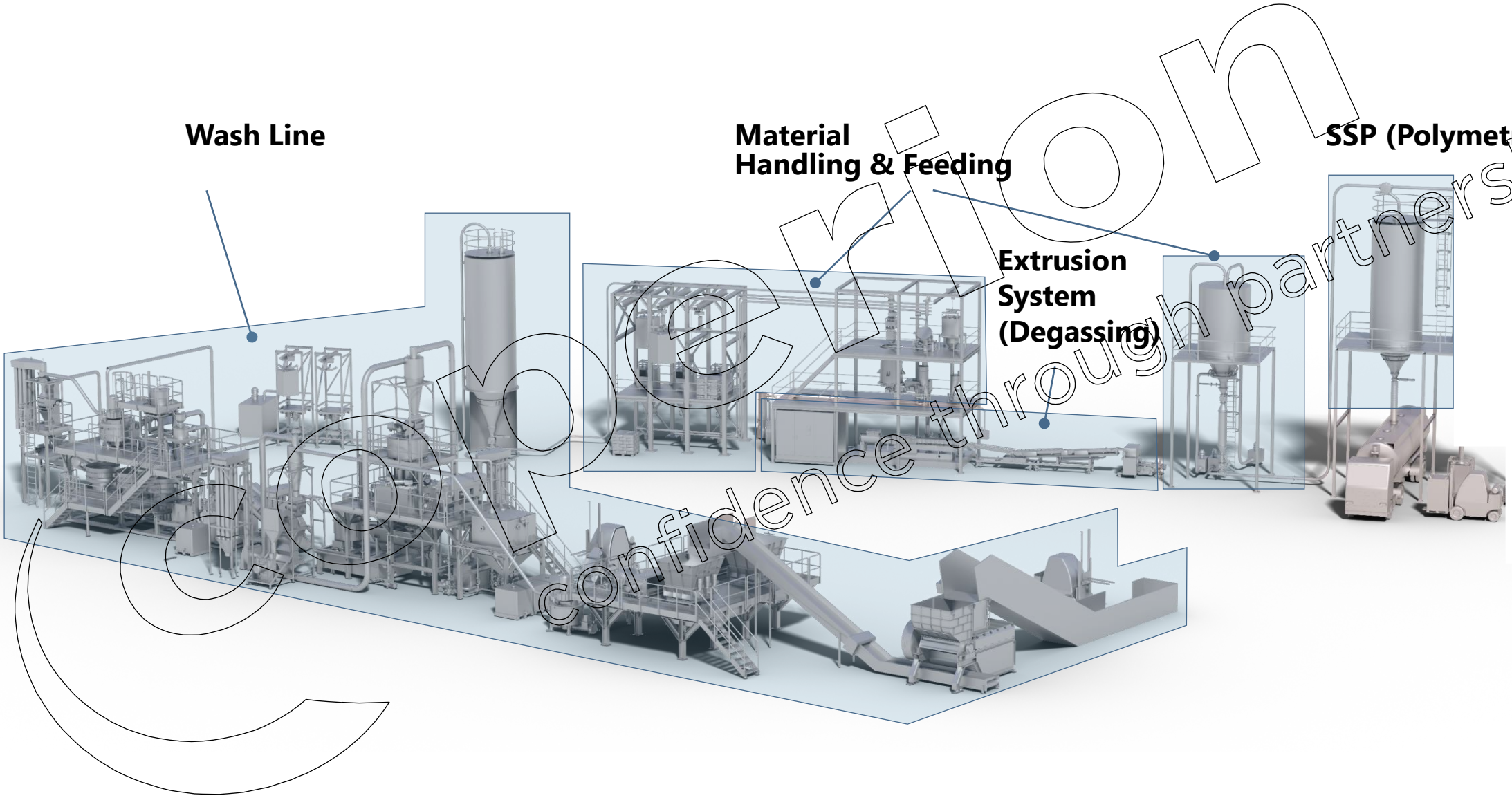
Recycling of PET Film and Bottle Flakes

Quality of pellets from different feedstocks





Challenges for PET recycling



Challenges for PET recycling

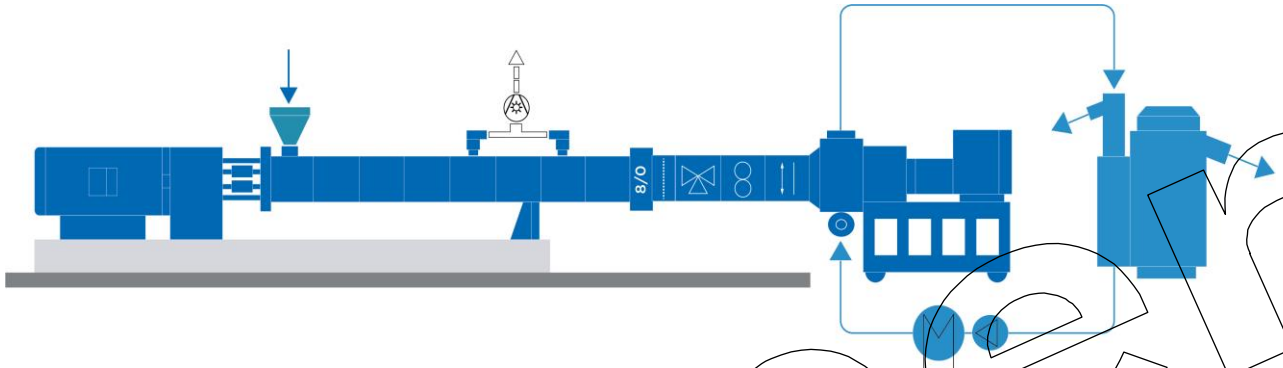
Material

Handling & Feeding

SSP (Polymetrix)

Mechanical Recycling of PET

Bottle to bottle including solid state post condensation



Non objection letter (together with Polymetrix)
→ **FDA and EFSA approval**

Freising, October 22, 2019

Expert opinion on the combination of Coperion twin screw extruders with the Polymertix SSP process for the reuse of post-consumer PET recyclate for direct food contact

As a conclusion, the Coperion twin screw extruders can be used for the production of PET pellets from state-of-the-art hot-washed post-consumer PET flakes, as long as the Polymetrix SSP process with the process parameters from the EFSA and FDA submissions are applied.

Dr. Frank Welle
(Head of Product Safety and Analytics Department)

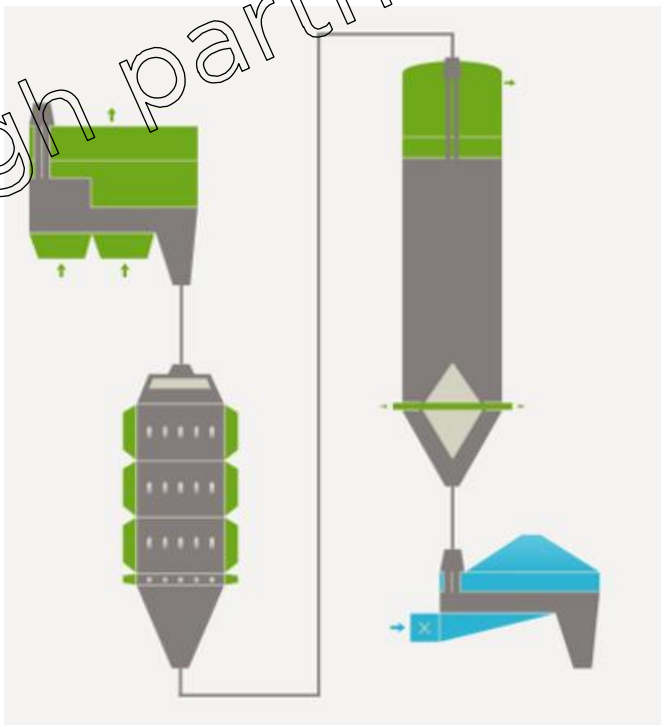
Brand approval
Listed in Atlanta

efsa
European Food Safety Authority

FDA APPROVED

„Hot" and crystallized pellets

SSP



Continuous system

Source: Polymetrix

PET plants

Application	Throughput
Bottle to Bottle (FDA/EFSA)	Up to 5.500 kg/h
BO-PET Film (incl. Recycling)	Up to 6.000 kg/h
PET Thermoforming sheet	Up to 3.800 kg/h
Masterbatch Preparation	Up to 1.000 kg/h
Glycolysis of bottle flakes	Up to 4.000 kg/h
Bottle to Fiber	Up to 4.300 kg/h
Wash plants / Components	Up to 5.000 kg/h

Herbold – Coperion – Polymetrix

A partnership for lifetime

2019
- First extruder purchased for Bottle to Bottle in Asia to replace an existing multi-screw extruder
- The capacity sold was 4200 kg/h, today running with 5200 kg/h

2022
- 3 more lines have been purchased in 2022

2024
- Further lines have been sold 2024

Future
- Customer is so satisfied with the performance that he will buy more systems in future, including for other PET applications and even higher throughputs


HERBOLD
MECKESHEIM
coperion

POLYMETRIX

a former Bühler Group Company

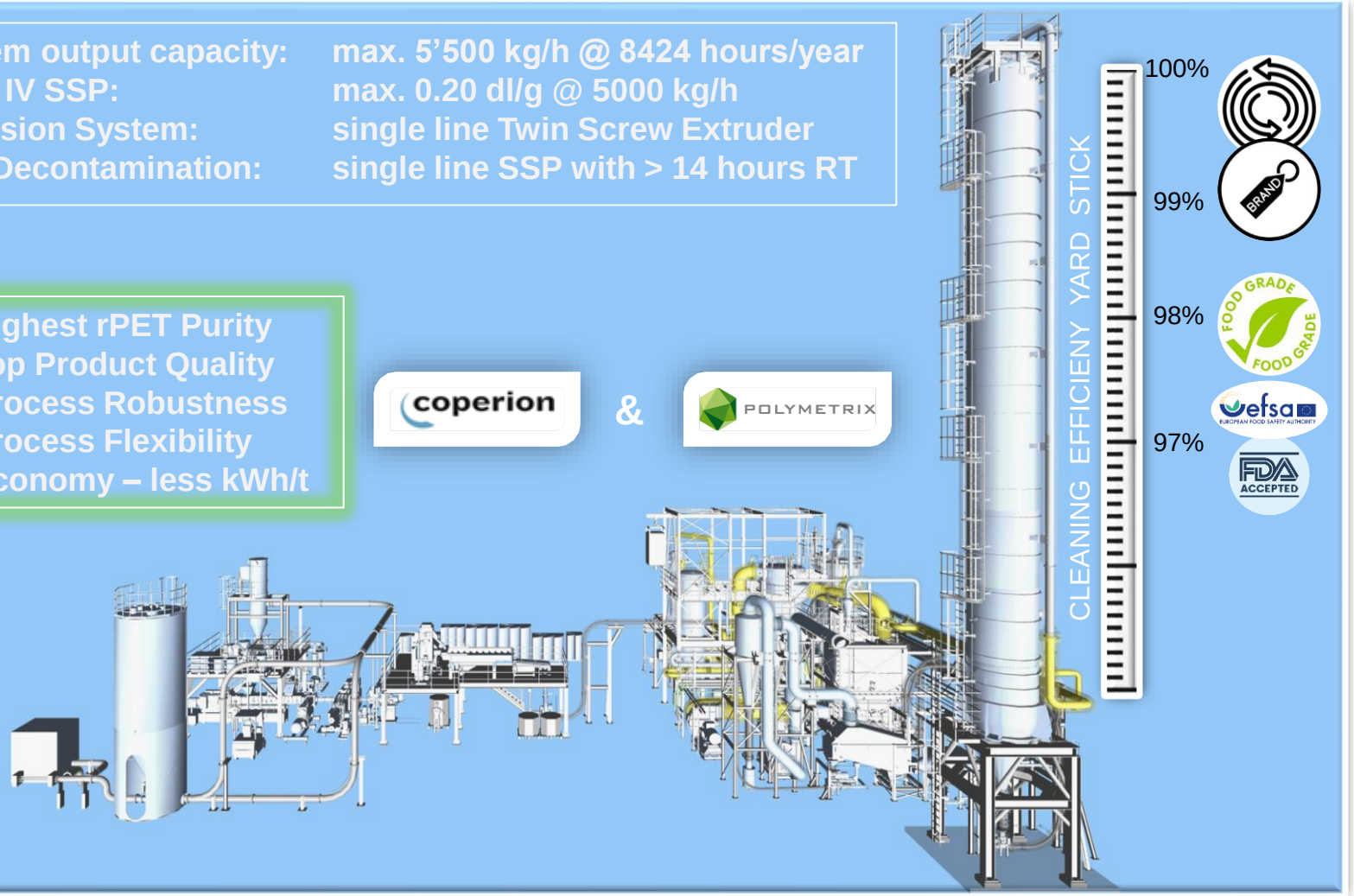
SSP as Key Decontamination Technology for Food Grade rPET Production

Food Grade rPET plant 5500 kg/h output

System output capacity:	max. 5’500 kg/h @ 8424 hours/year
Delta IV SSP:	max. 0.20 dl/g @ 5000 kg/h
Extrusion System:	single line Twin Screw Extruder
SSP Decontamination:	single line SSP with > 14 hours RT

- Highest rPET Purity
- Top Product Quality
- Process Robustness
- Process Flexibility
- Economy – less kWh/t

coperion & POLYMETRIX



Why SSP Decontamination for rPET ?

SSP – Solid State Polycondensation (Festphasen Nachkondensation)

SSP decontamination with a residence time > 14 hours @ min. 197°C has a *stand-alone acceptance* from EFSA, FDA and major brand owners

SSP is considered as the most reliable decontamination technology with a wide operating window

SSP diffusion process is the main contributor for volatiles and low volatiles removal form PET

SSP facilitates the repair of the polymer structure from damages occurred during the thermal history

SSP with extensive residence time at temperature leads to highest purity rPET, "necessary to keep PET circular"

Requirement: long-term circularity of PET:

"rPET of highest purity (exceeding EFSA) is a prerequisite to maintain the circularity of PET" in multiple loops!

One important answer from the industry:

"Extensive SSP decontamination treatment leads to a rPET quality with highest purity!"

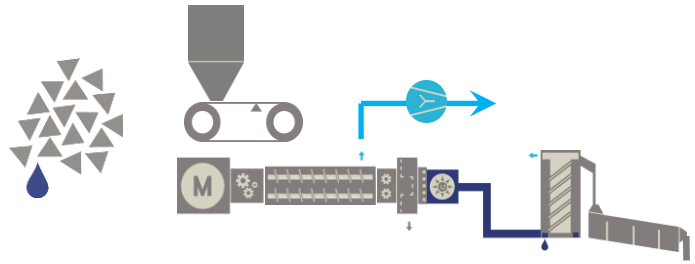
POLYMETRIX

Superior rPET Quality with SSP Technology

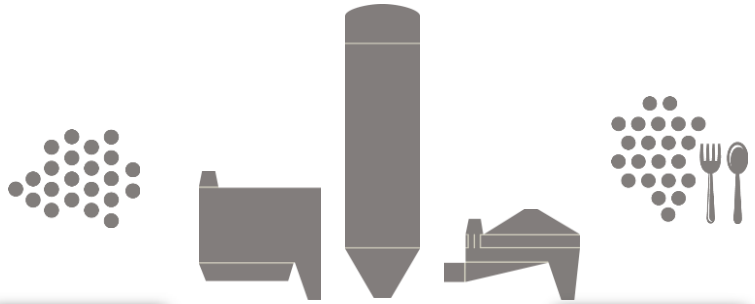
Extrusion with or without soild treatment

SSP decontamination process

Food safety



wet flakes from wash line



pellets from extrusion

food grade rPET pellets

requirements

Brand Owners

EFSA

FDA

Most advanced technology offering for superior rPET quality:

Extrusion process / partial decontamination effect (hot spherical or cold cylindrical pellets)

coperion

Long residence time SSP decontamination process with stand-alone EFSA/FDA & brand owner acceptance

POLYMETRIX

Alternative offerings from vendors (short time diffusion process) leads to inferior purity):

EFSA/FDA accepted: Combined Extrusion & short residence time SSP process < 8 hrs

EFSA/FDA accepted: Extrusion with pre- & post-treatment process

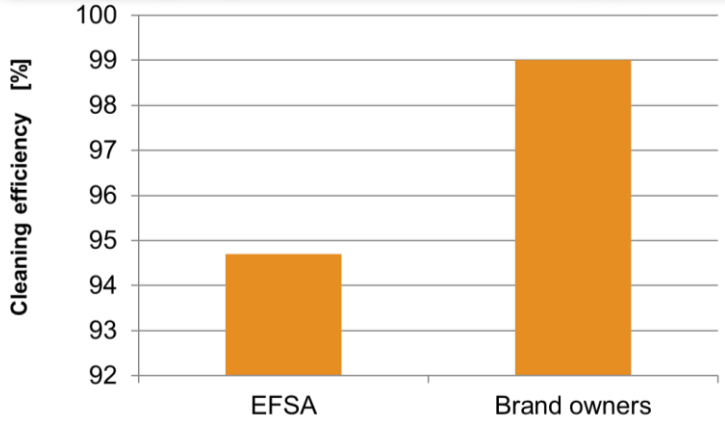
POLYMETRIX

Requirements on rPET purity

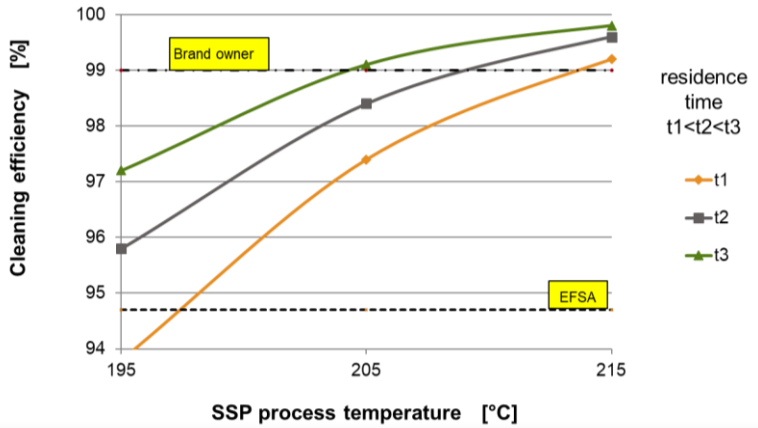
Sequence of priority for rPET purity requirements:

1. Long-term circularity of PET requires the highest level rPET purity!
2. Safety precautions of brand owners require a rPET purity far above FDA / EFSA
3. FDA / EFSA limits are minimal requirements for food safety by the authorities only

rPET purity requirements EFSA vs. Brand Owners



Long SSP residence time at temperature for high purity

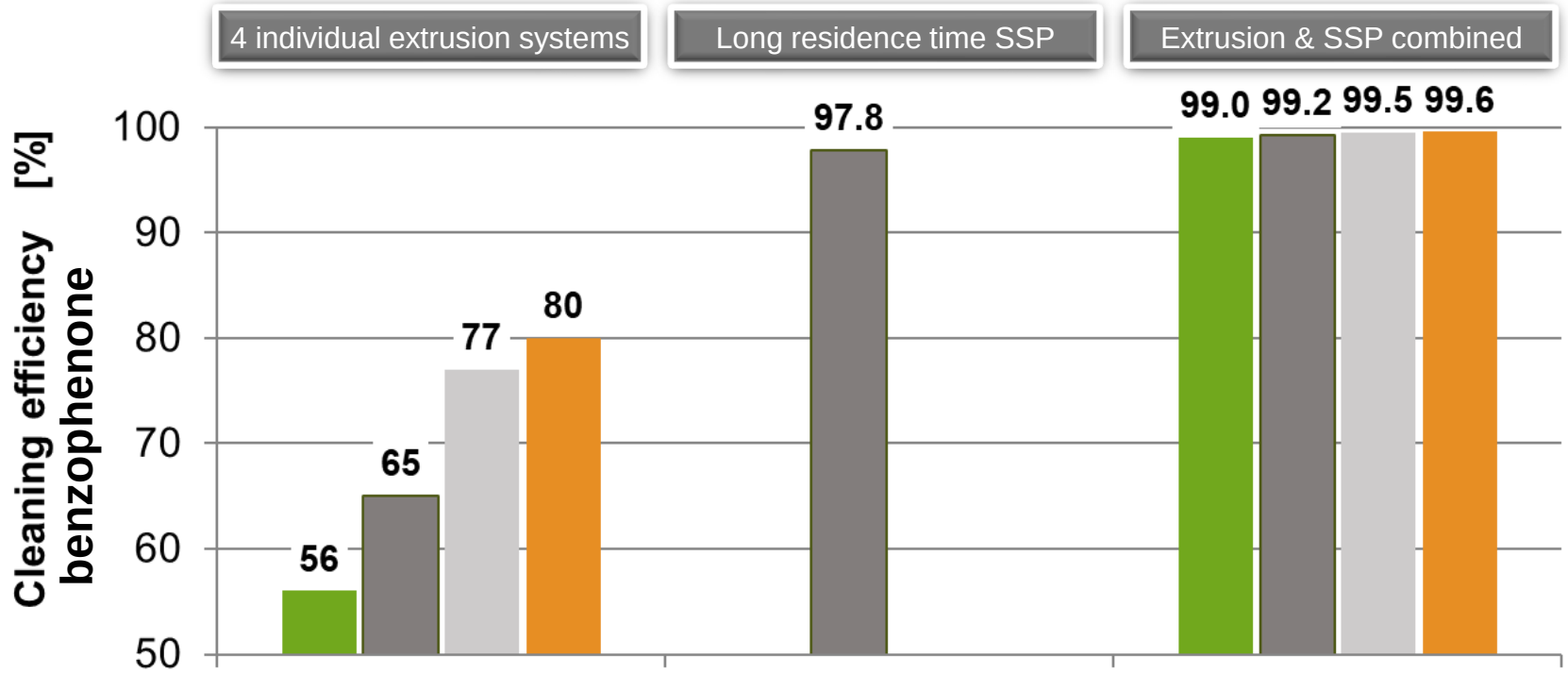


SSP is a diffusion controlled process.
The decontamination / purification efficiency is a function of residence time, temperature and process conditions in the SSP reactor.

POLYMETRIX

Distribution of Cleaning Efficency

Comparison of the cleaning efficiency distribution for benzophenone between
4 individual extrusion systems combined with a long residence time SSP system



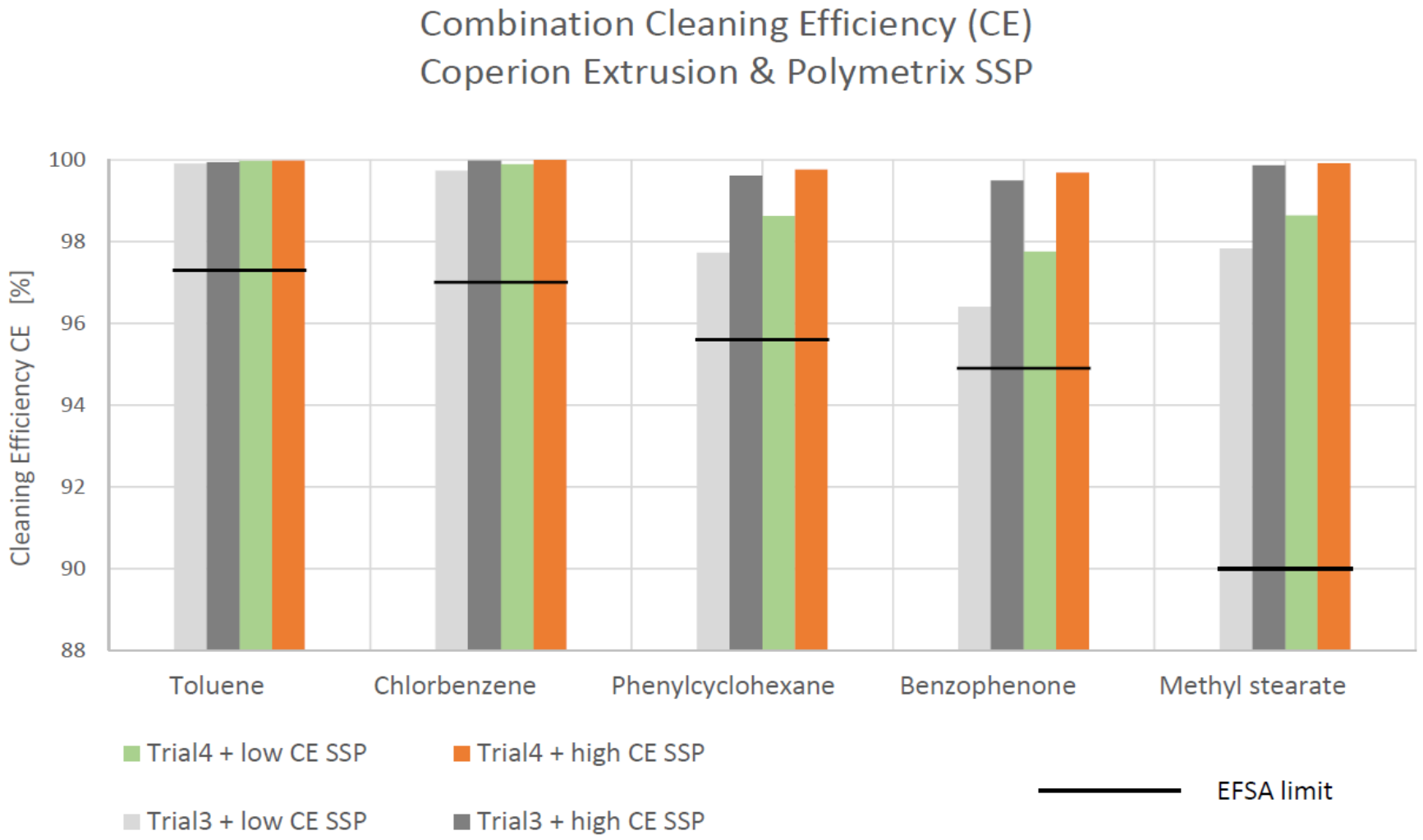
CLEANING EFFICENCY of 4 individual extrusion systems with different decontamination performance

CLEANING EFFICENCY of long residence time SSP decontamination system

CLEANING EFFICENCY of combined extrusion and SSP system

POLYMETRIX

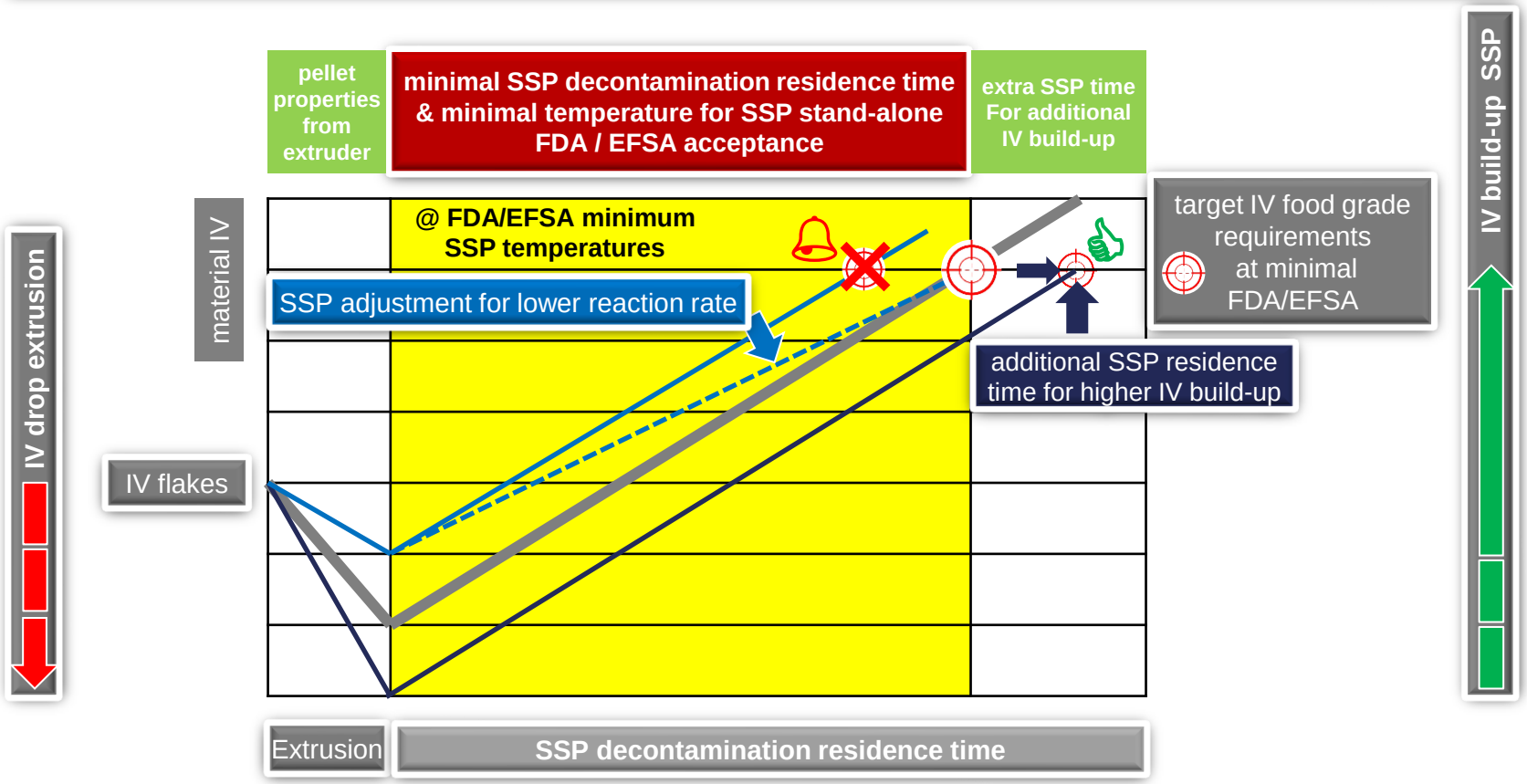
Cleaning efficiency : Coperion-Polymetrix



POLYMETRIX

SSP adjustment within FDA/EFSA window

High flexibility via SSP adjustments according to IV drop in extrusion and requirement of final IV within FDA/EFSA operation window



POLYMETRIX

Thank You for Your Attention!

POLYMETRIX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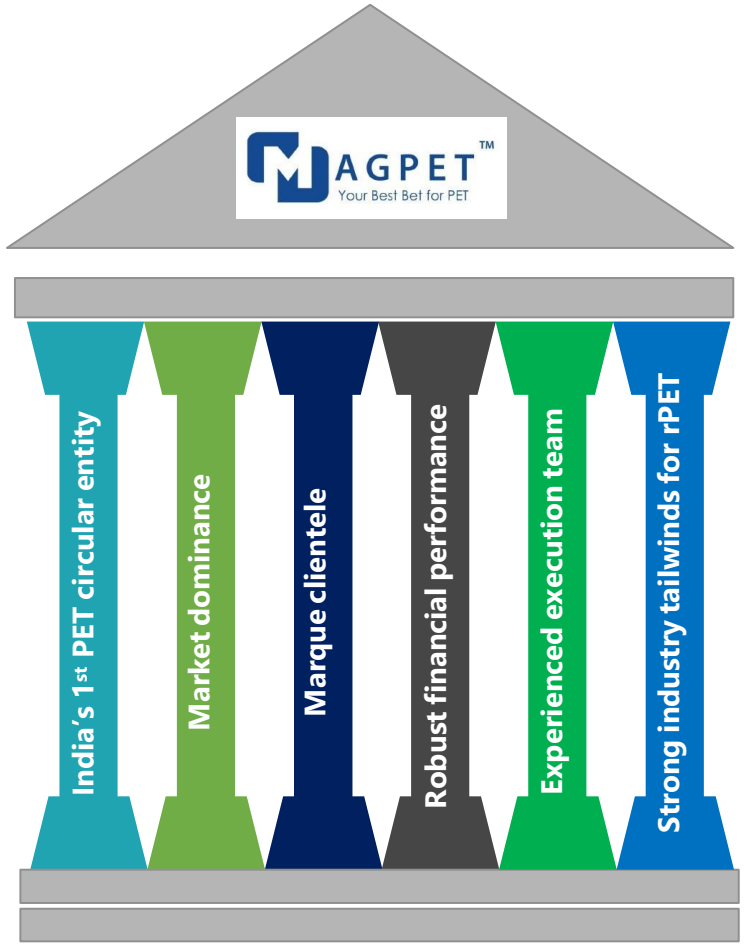
Magpet Polymers: Pioneering rPET Recycling in India

Introducing cutting-edge recycling capabilities for bottle to bottle, food-grade rPET production.

- **Devendra Surana -Founder & Managing Director**
- **Indroneel Goho - President & CEO**

East & North-East India's largest PET converter; poised to be India's 1st PET circular entity

Key Highlights



1. **Niche market position as India's 1st PET Circular entity**
   Backward integration into manufacturing of **recycled PET (rPET) flakes** and **rPET pellets** to establish the company as **India's first bottle-to-bottle PET converter**

2. **Market dominance**
   #1 PET converter in East & North-East India. It commands **over 30% market share** with an installed capacity of ~50,000 MTPA in these regions

3. **Established base of coveted clients across industries**
   Supplier to leading FMCG companies such as Bisleri, Adani, Emami, Dabur, IRCTC, Diageo, etc. Recently added world's most valued* global soft-drinks company, **Coca-Cola,** and one of India's largest B2C brands, **Reliance Retail,** to its client list

4. **Posting exponential growth**
   Posted 3-Year Revenue **CAGR** of ~**28%**
   Led by **visionary promoters** with an experience of **40+ years** in the plastic packaging industry who are supported by a team of highly qualified and skilled **professionals** having long standing association with the company

5. **Strong industry tailwinds for rPET**
   rPET offers an attractive opportunity following constructive actions taken by all the **stakeholders including Governments, industry, and consumers, etc.** to move towards **recyclability**

Source: Company management

India's Largest Integrated Integrated Recycling Facility

1 Location

Vidyasagar Industrial Park, Kharagpur, Bengal

2 Capacity

45,000 metric tons annually

3 Innovation

Closed-loop PET bottle-to-bottle recycling

European Technology Partners

HERBOLD MECKESHEIM

1st German Washing Line in India

coperion

1st Twin-Screw 5.5 MTPH Extruder in India

POLYMETRIX
a Sanlian Bühler Company

1st 5.5 MTPH SSP in India

Social Inclusion Model

Waste Pickers Supported	10,000+
Region Covered	Bengal and East/Northeast India India
Impact	• Improved livelihoods & waste waste collection • Community Impact • Promoting Circular Economy in Economy in the region • Reducing plastic waste • Creating employment opportunities

This significant investment underscores the international recognition of Magpet's innovative approach to PET recycling and its potential impact on sustainability in India.

British International Investment

British International Investment

Investment Amount

USD 24 Million

Purpose

Funding Magpet's innovative recycling initiative

Impact

Facilitate growth & expansion of Magpet in India

Accelerating sustainable recycling in India.

metapet

Thinking eco-logically

Thank You

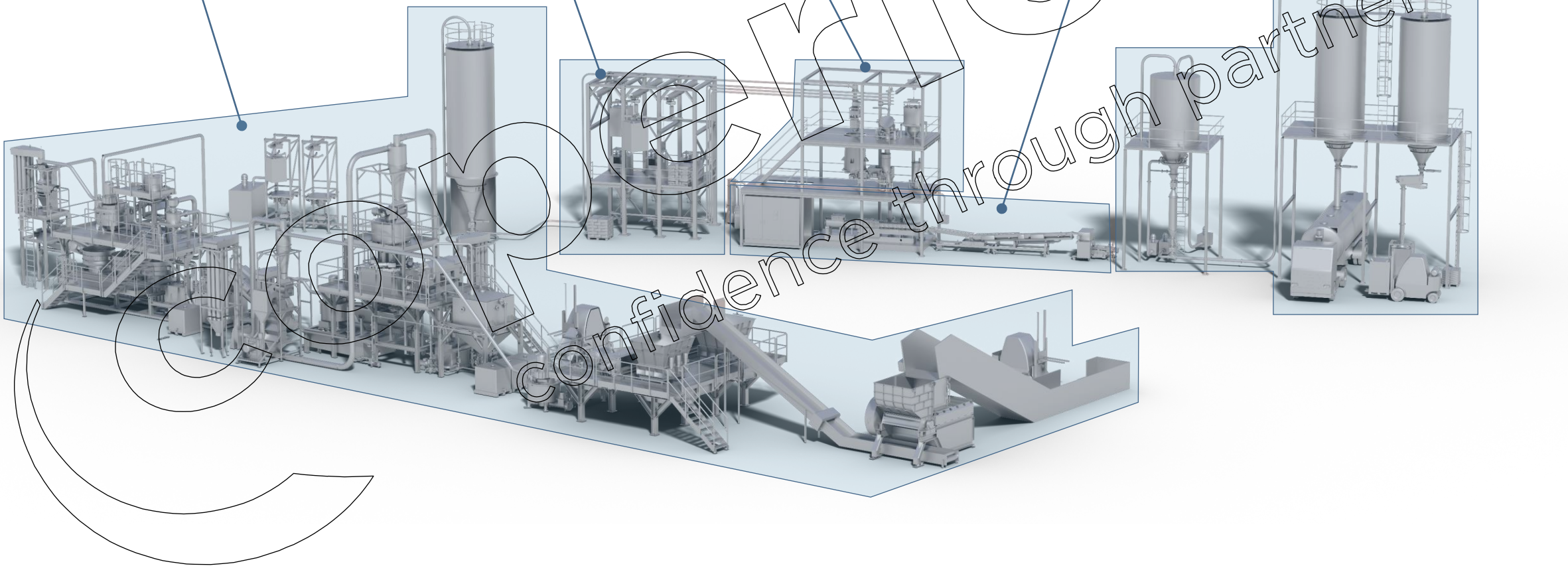

HERBOLD
MECKESHEIM
coperion

Coperion Full-Scale Turnkey Systems

Miguel Terán
Sales Manager Compounding Plants

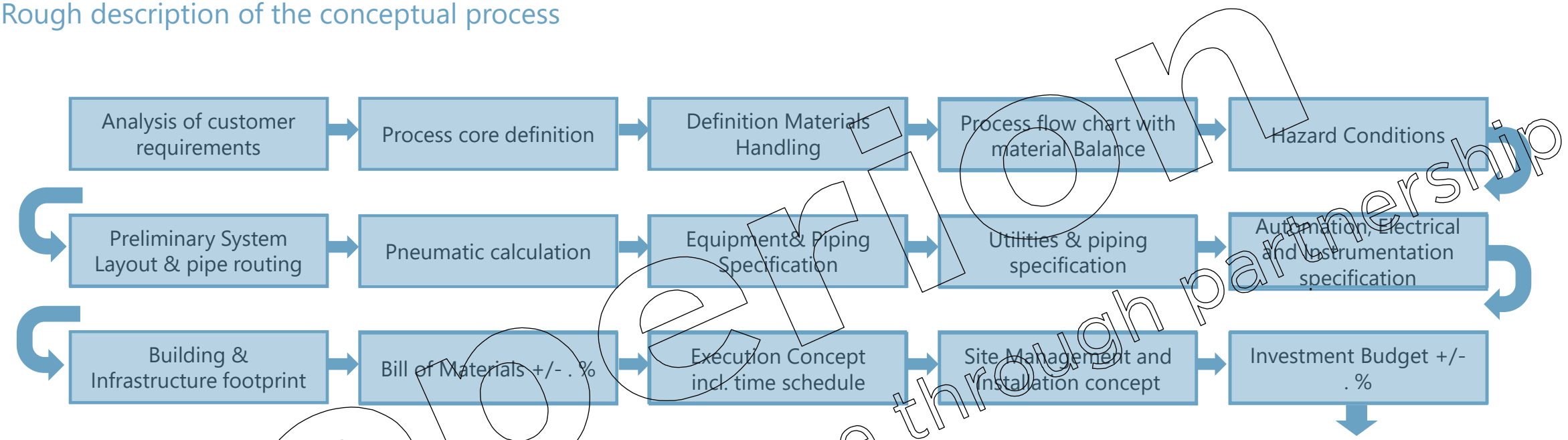
Coperion Full Scale Turnkey Systems

Coperion Full-Scale Turnkey Systems



Plant Conception – Basic Considerations

Rough description of the conceptual process

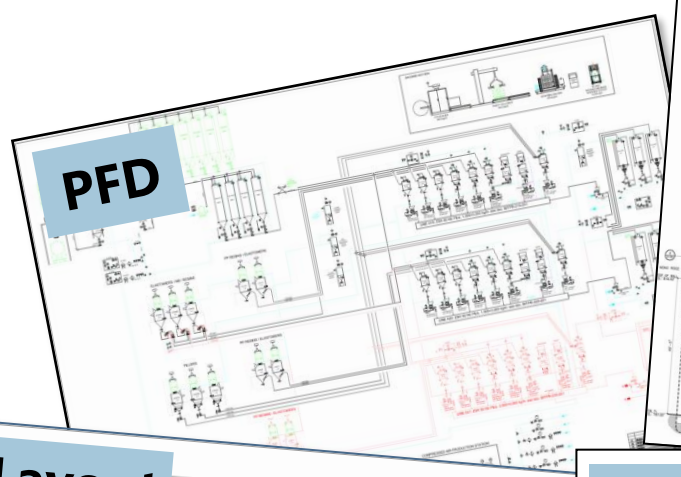


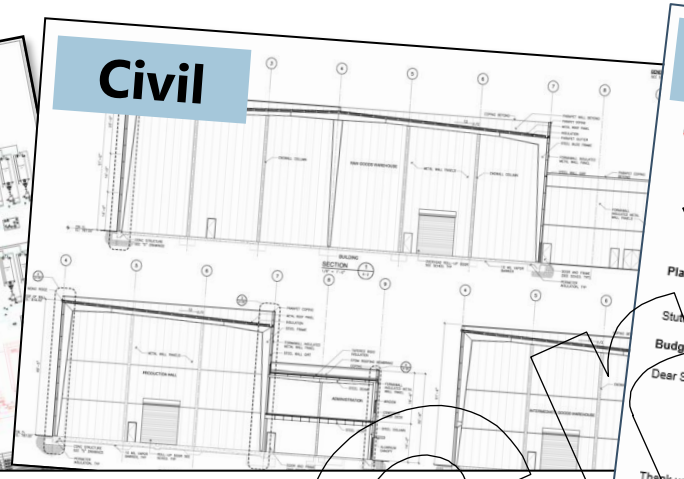
For the ***Complete Plant Concept***, our ***own experts*** work together with ***design partners*** for the infrastructure / civil section. But we are as well open to partner up with our customers or their consultants / contractors and share the scope of the ***conceptual study***. We can provide essential deliverables up to the maximum content like contractors do.

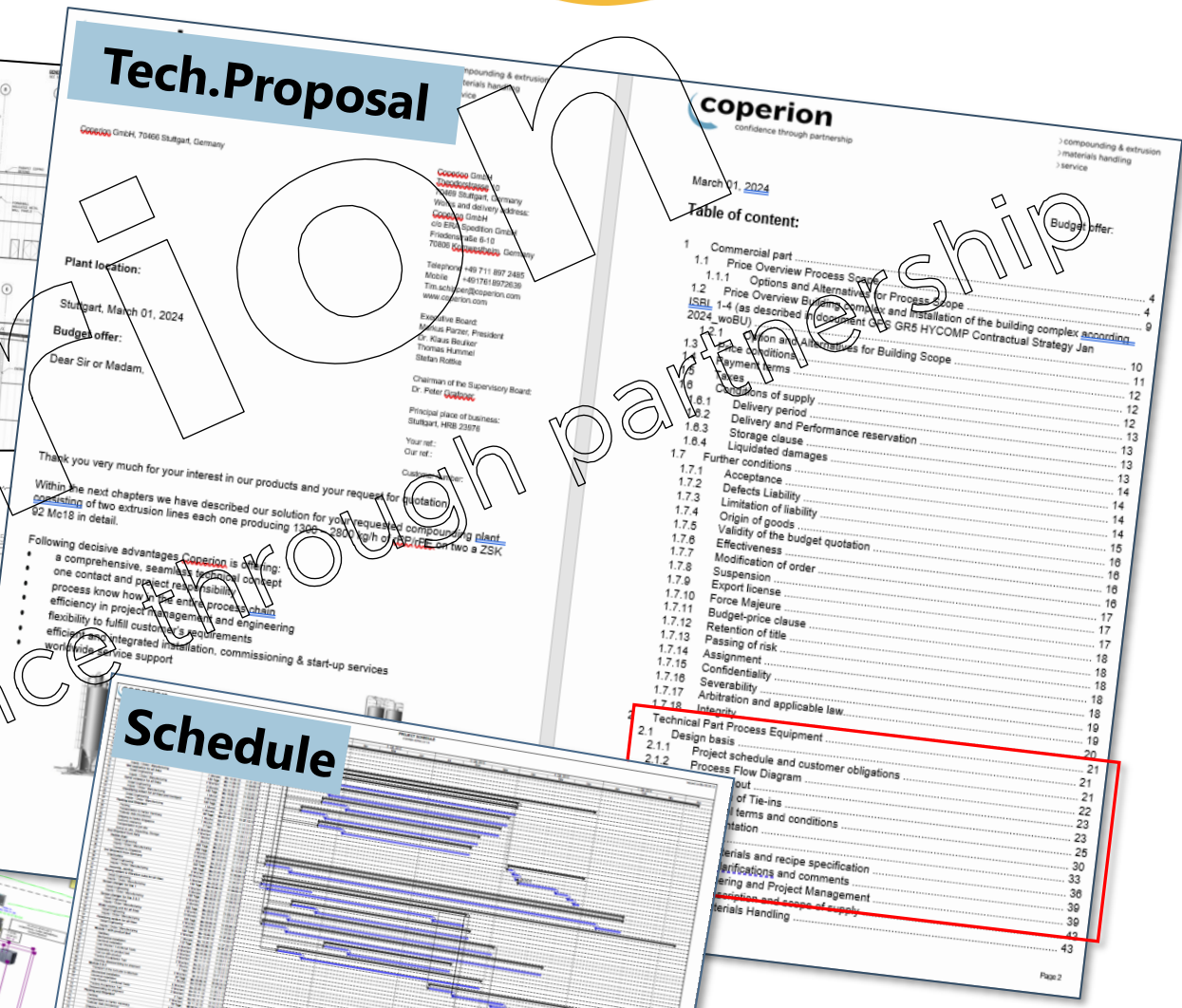
Conceptual Study with documents package

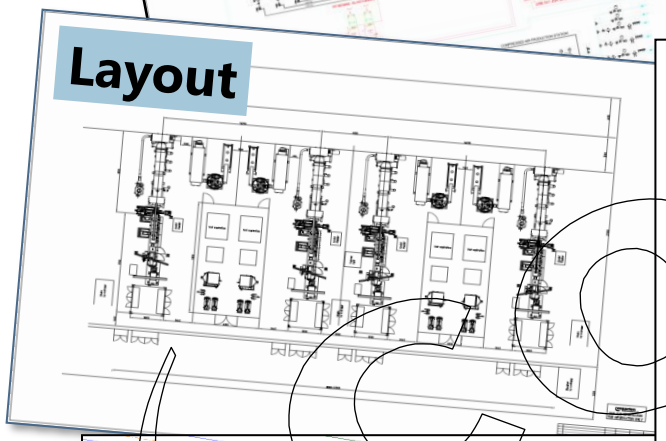
- Process Flow chart
- Plant layout
- Equipment, piping & utilities specification
- Automation concept
- Technical description
- Execution concept & time schedule
- Budgetary assumption of the investment volume

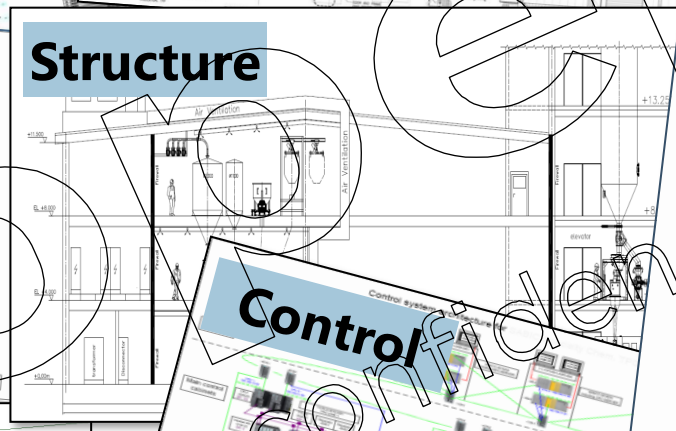
Typical Documentation

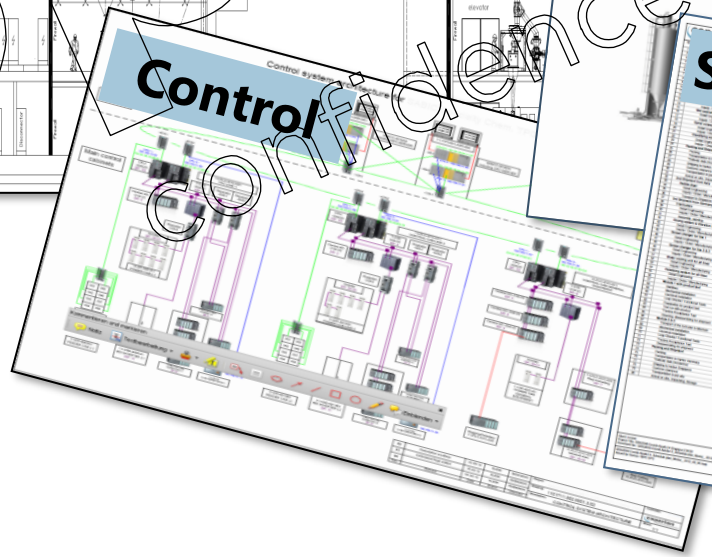


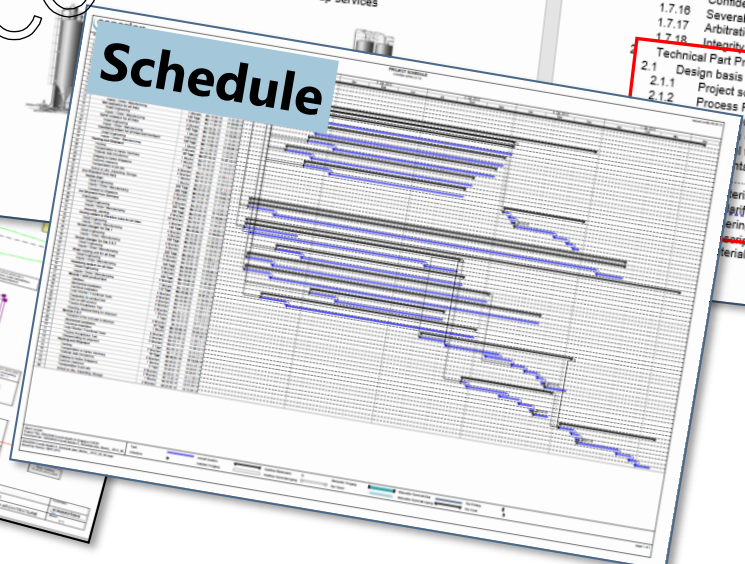


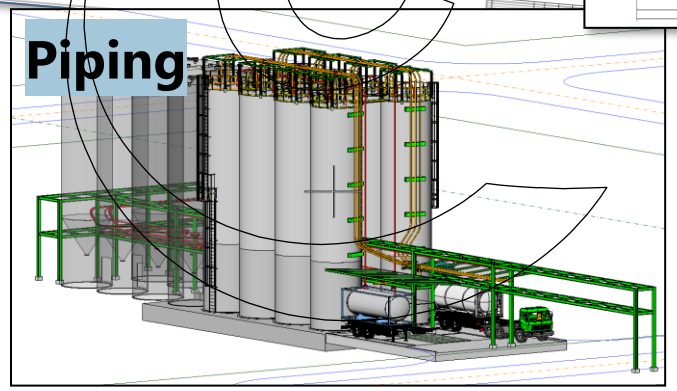












System Integration - Basics

The Perfect Plant Concept – Requirements to be brought in balance

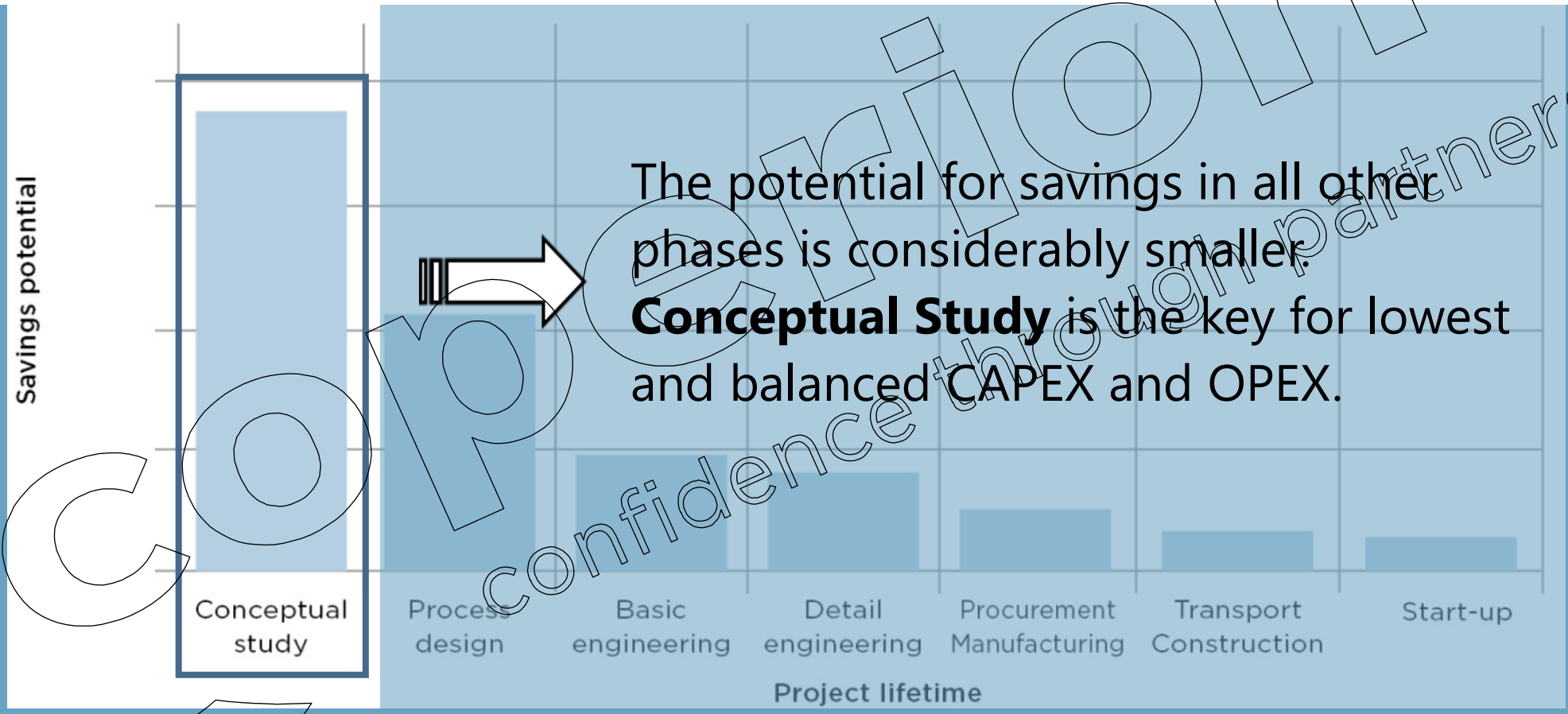
- Construction Management
- Local Labour
- Site Facilities, Storage
- Building Services
- Necessary Modifications
- **Process Requirements**
- Structural Steel
- Construction & Operation Permits
- **Layout Requirements**
- Soil Properties
- Infrastructure Constraints
- Transport
- Civil Works
- Environmental Regulations
- Electrical, Inst., Contr.
- Package Units
- Time Schedule
- Plant Operation
- Taxes & Duties

Optimum Plant & Realization Concept

Comprehensive knowledge of the ***process*** and all **other project aspects** builds the basis for the optimum plant concept and the best realization strategy for the project.

System Integration - Basics

Decreasing cost saving potential during project lifetime



The potential for savings in all other phases is considerably smaller.
Conceptual Study is the key for lowest and balanced CAPEX and OPEX.

Turnkey Processing Plants

Complete Compounding Plant in KSA, incl. demolition and utilities

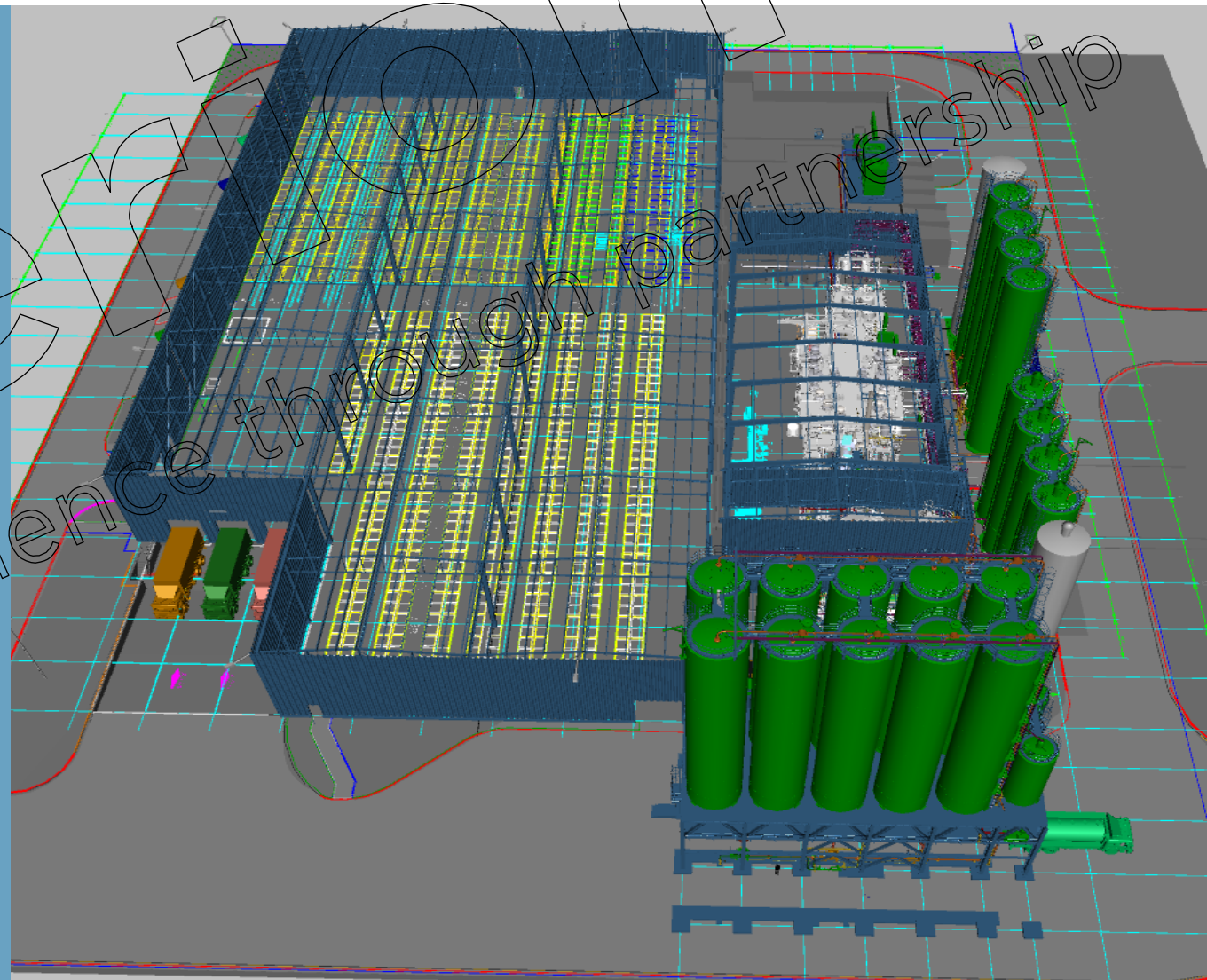



- ✓ Integration of a compounding plant with four extrusion lines in an existing building
- ✓ Extruders incl. LIW feeders and pre-hoppers as modularized system
- ✓ Raw and finished Product storage & Handling
- ✓ Packing and Palletizing
- ✓ Demolition of old facilities
- ✓ Piling, foundations, steel structures, building modifications and all other required civil works
- ✓ Utilities generation and distribution system
- ✓ All other services and supplies to build a complete plant.

Turnkey Processing Plants

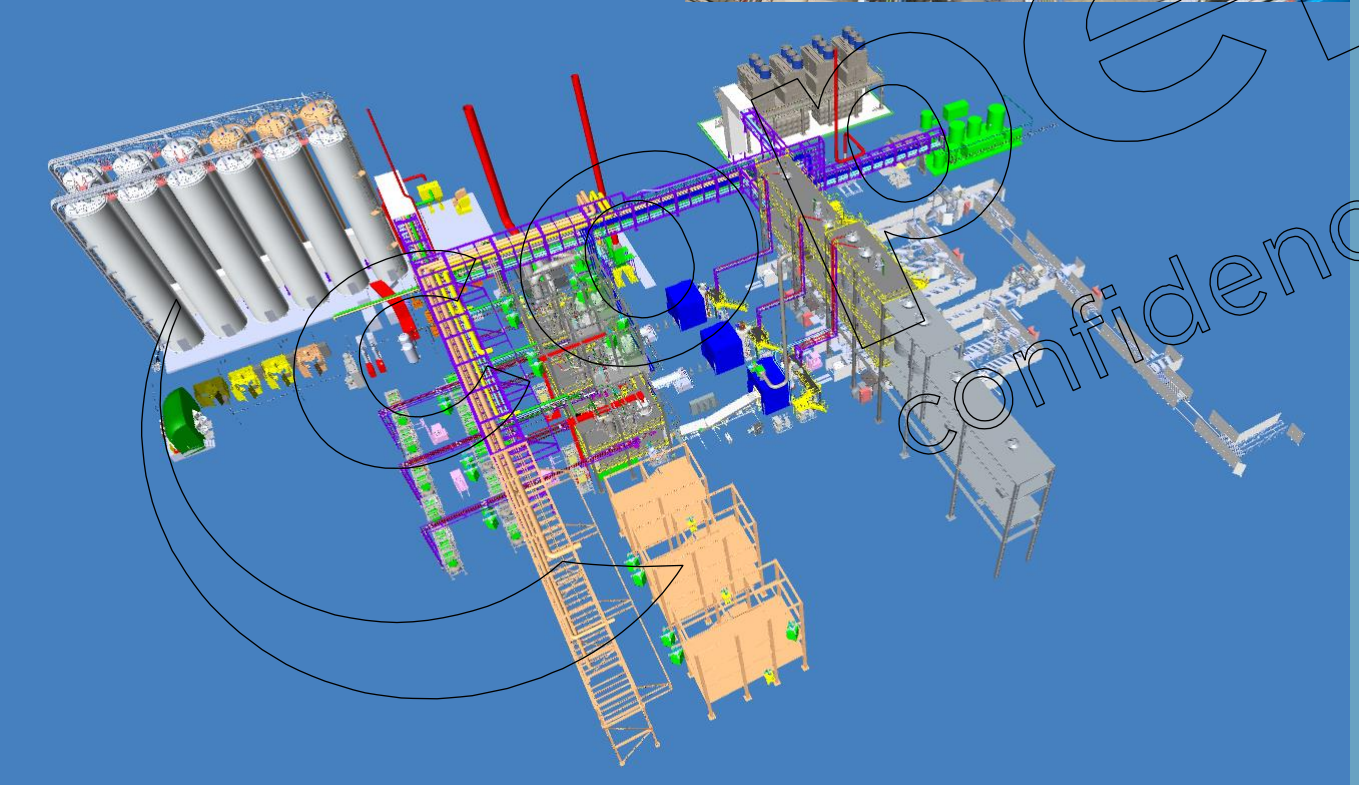
Complete Compounding Plant in Europe, incl. building with partner

- ✓ Compounding Plant on Green Field
- ✓ Production building
- ✓ Office / maintenance complex
- ✓ Warehouse incl. logistic office
- ✓ Roads, parking and other open areas
- ✓ Piling, foundations, steel structures, and all other required civil works
- ✓ Utilities generation and distribution system
- ✓ All other services and supplies to build a complete plant.



Turnkey Processing Plants

Compounding plant for PA/PBT in Asia, regular customer



- ✓ PM Handling (truck unloading, silos, BB stations, piping & conveying)
- ✓ Mixing stations / feeding systems / extruders
- ✓ Pelletizing systems, classifier, spiral conveyor
- ✓ Finished good handling (conveying, silos, cleaning system)
- ✓ Packaging lines for bag and BB
- ✓ Steel structures (430 tons) and piping systems (7,6 km)
- ✓ Auxiliaries (water treatment, cleaning oven, dry and wet aspiration)
- ✓ Entire control system with hard- & software and cables (78 km)
- ✓ Site management and supervision by multiple Coperion sites

Turnkey Processing Plants

Two extrusion lines for Middle East, modular

- ✓ Modularized systems
- ✓ Delivery in several containers
- ✓ Each line as a plug and play system
- ✓ Pre-commissioning (until ready for start-up) in Coperion premises

Summary and Essence

coperion is the **ONLY** worldwide supplier that designs and produces the core equipment for the complete process chain by itself.

coperion offers a unique experience in both process and material handling know how

Our customers benefit from our added value:

Design and execution of an ***entire process plant*** is a complex exercise. Our detailed ***knowledge of the complete process chain*** and ***experience*** in providing numerous production lines, enables us to provide the ***right process solution***. Our ***deep understanding*** of everything which is around the plant's process core enables us to develop, whilst balancing and harmonizing all required disciplines, for the ***perfect overall solution of your plant***.

This is what the experience of Coperion stands for.

Thank you!

Miguel Terán
Sales Manager Compounding Plants

Professional Customer Service

Georg Vögele
Sales / Key Account Manager | Coperion

1

Coperion and Herbold Meckesheim – Global Service Network

2

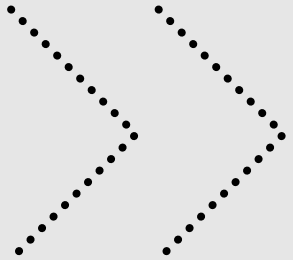
Services, Products and Portfolio

3

Discussion & Questions

1

Coperion and Herbold Meckesheim – Global Service Network



2

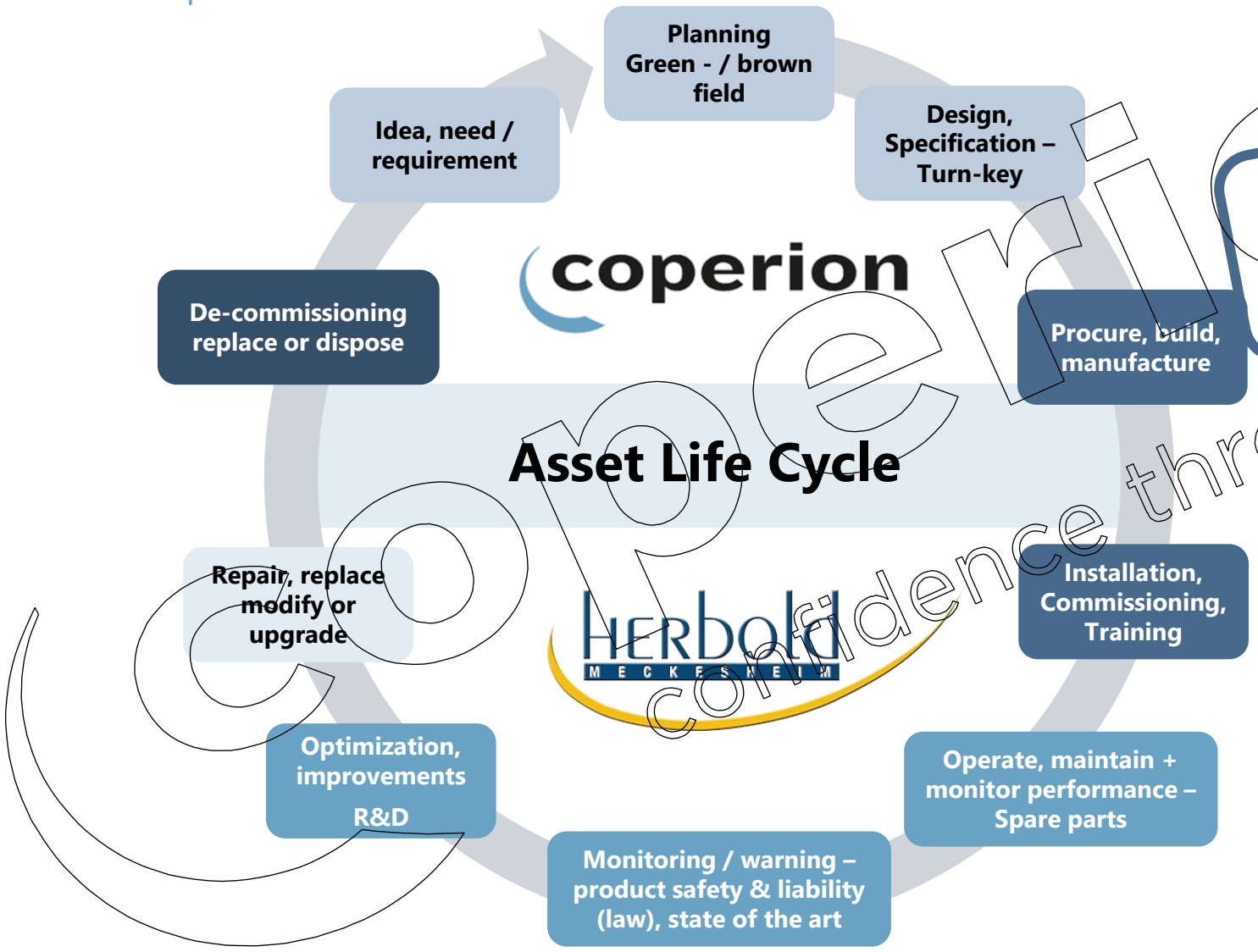
Services, Products and Portfolio

3

Discussion & Questions

Services, Products and Portfolio

Full-service provider



coperion Service is not only selling parts!

Services, Products and Portfolio

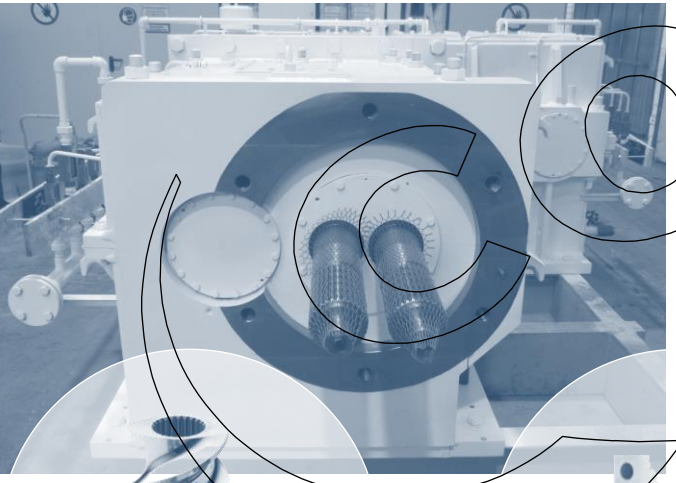
Service Agreements – Customized Offering

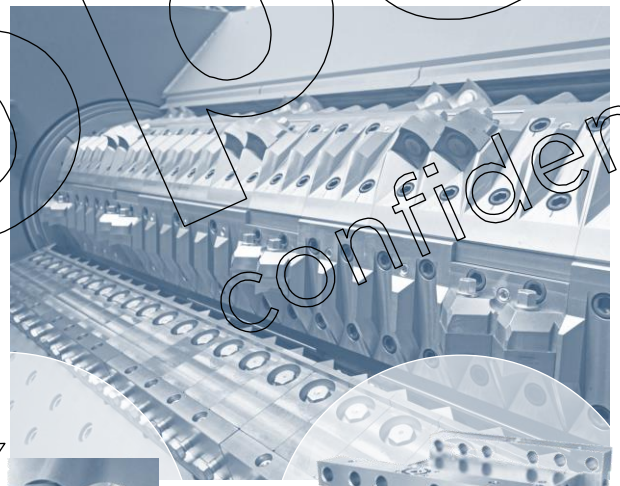
Recycling Plants	Preventive	Predictive	COGS	Safety
Inspection				
Functional	✓			
Vibration Measurement (Gearboxes)	✓	✓		
Wear measurement	✓	✓		
Maintenance				
Supervision of repairs			✓	✓
Functional test	✓		✓	✓
Startup support	✓		✓	✓
Remote Support				
Fast lane remote support (Extrusion & Conveying)			✓	
Diagnosis and Trouble shoot		✓	✓	
Remote Access control and support	✓		✓	
C-Beyond I4.0				
Basic (OEE, Downtime tracking, Data monitoring)		✓		
Plus (Basic + Lifecycle management, Sustain app)		✓		

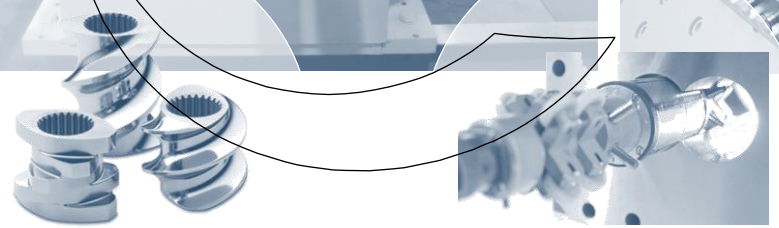
Services, Products and Portfolio

Services, special programs – Customized Offering

- Spare part lists / MyCoperion; MyHerbold
- Screw shaft exchange program
- Gear box and barrel, pool exchange program
- Service packages
- Sustainability and energy saving







Overall benefits:

- ✓ Transparent, projectable costs and cost savings
- ✓ Increasing availability and reliability of machine train
- ✓ Increase safety (process and production)
- ✓ Reduce downtimes and unforeseen production losses and emergency
- ✓ Predictive and preventive / condition-based maintenance

1

Coperion and Herbold Meckesheim Global Service Network

2

Services, Products and Portfolio

3

Discussion & Questions

Discussion & Questions

>> **Your needs, requests, interests and demands**

>> **Our solutions, portfolio and proposals.**

Thank you!

Georg Vögele
Sales / Key Account Manager | Coperion

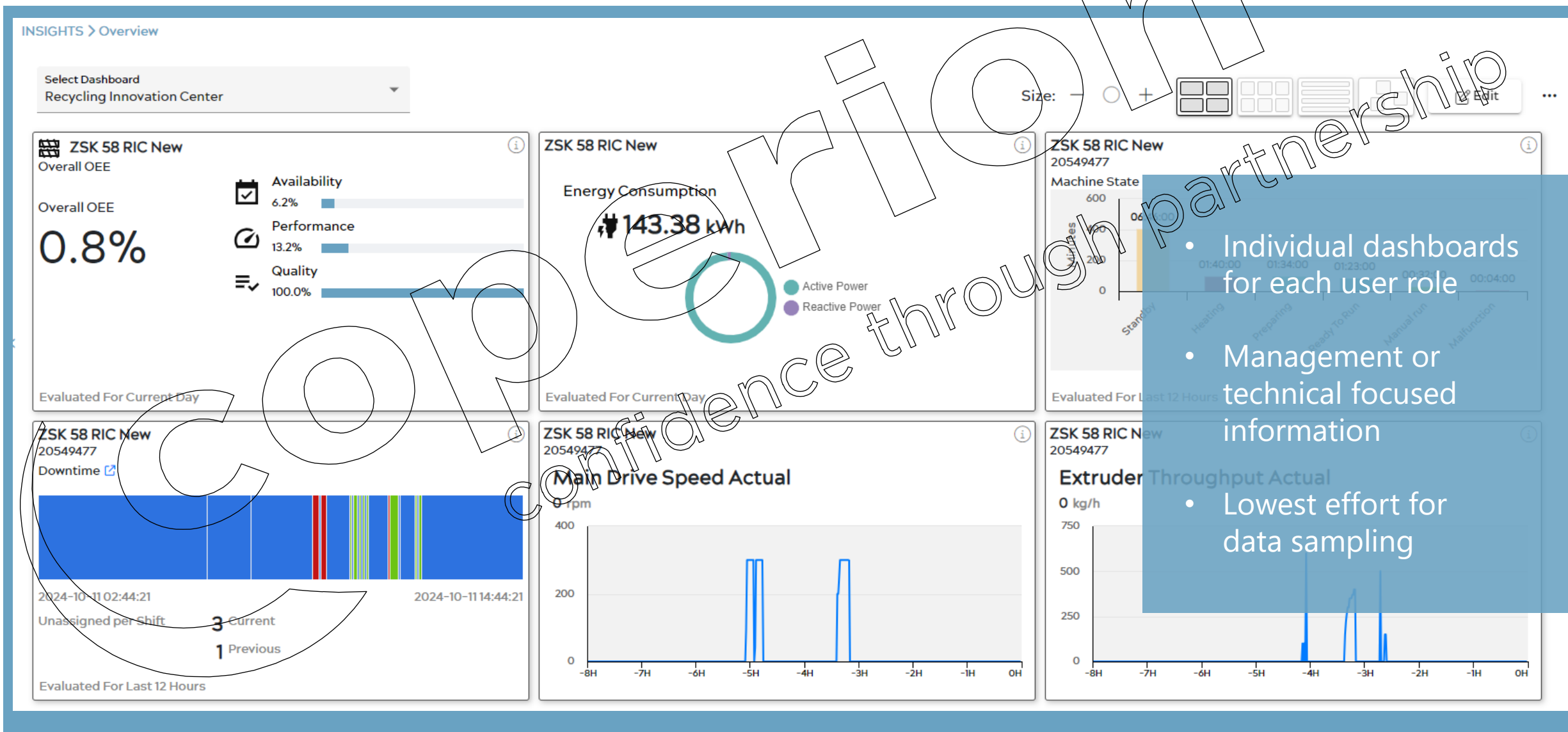
C-BEYOND

How to Boost Productivity and Efficiency with Digital Solutions

Tanja Karrer
Automation & Control | Coperion

Markus Schmudde
Head of R&D | Coperion

More Efficiency Based on Data



- Individual dashboards for each user role
- Management or technical focused information
- Lowest effort for data sampling

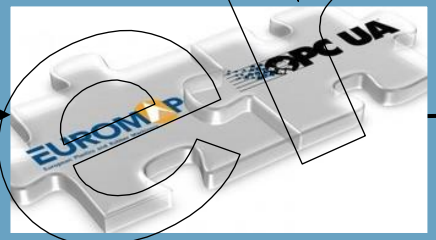
Data Collection

From field level to cloud

Machine
Field level

Machine control
(HMI, PLC)

OPC UA Server
OPC 40084



Remote
Connection

C-Beyond
IIOT

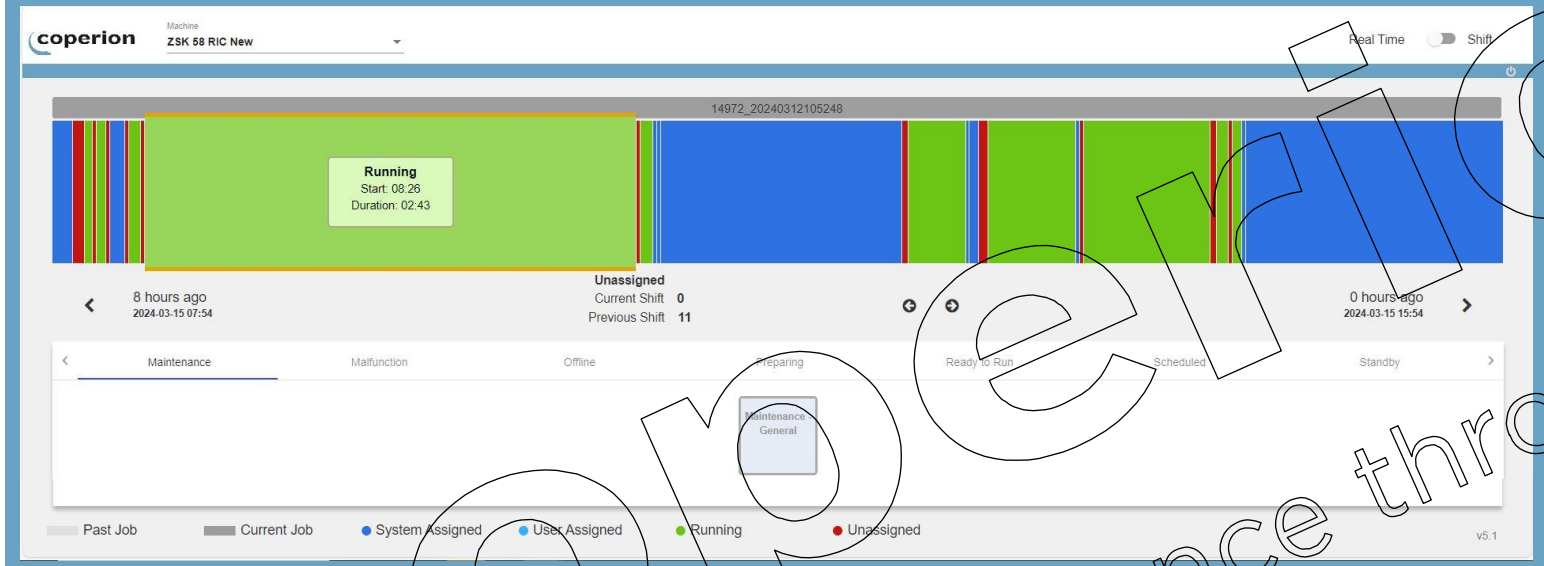
Evaluated data

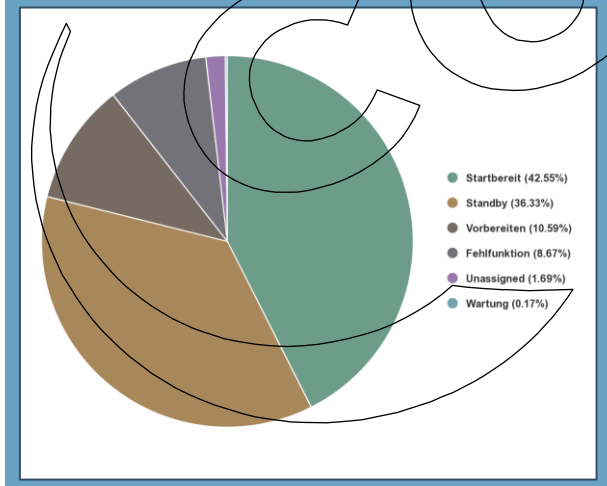
Evaluated data

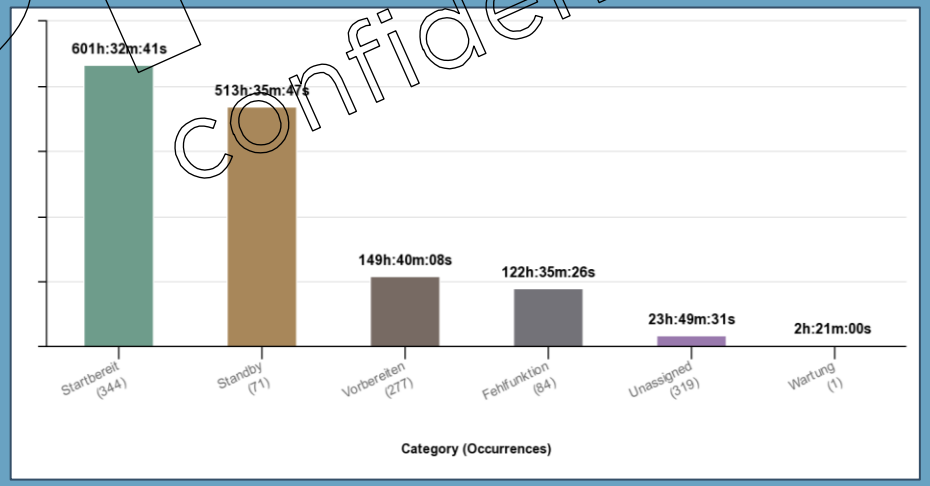
- Data is often available but not yet used
- Provide new, calculated signals from existing ones (e.g. energy consumption, machine states, etc.)
- Integration of additional measurement technology, e.g. for condition monitoring

Downtime-Tracking

Full visibility into your machine's performance



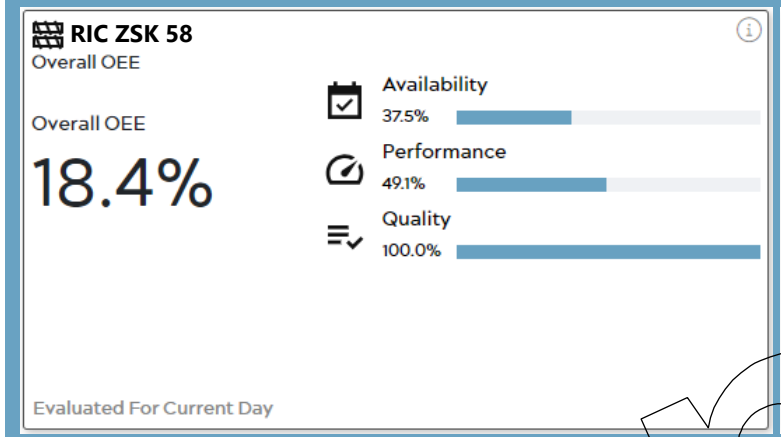


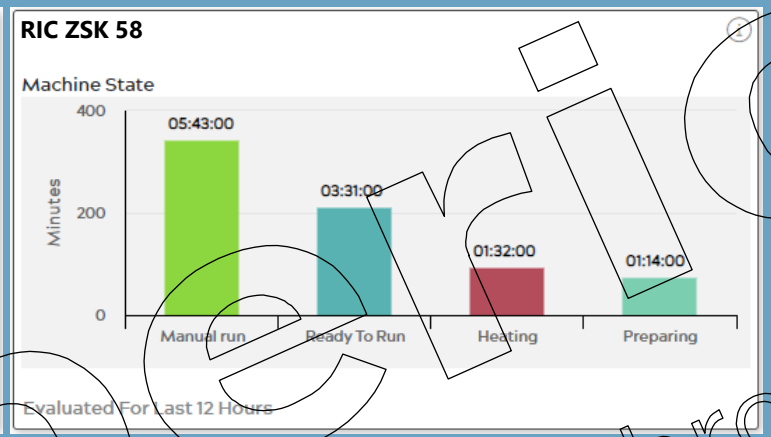


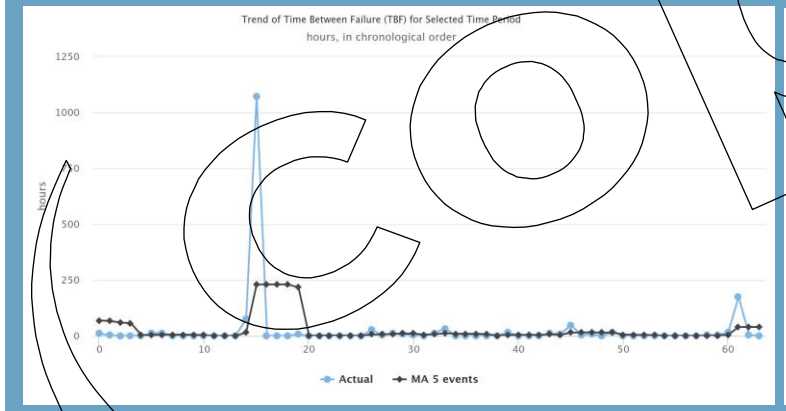
- Track downtime of the plant
  - Top level view
  - Detailed analytics
- Machine states detected by control system automatically
- Root causes can be assigned individually
- Operators are actively participating in the tracking process

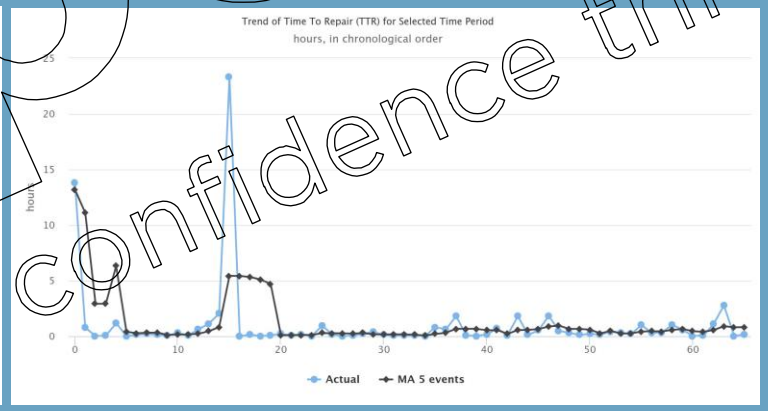
Equipment Effectiveness

All KPI's at a glance









$$\text{MTBF} = \frac{\text{Uptime (hours)}}{\text{\# failures}} = \frac{1{,}627.73 \text{ hours}}{64 \text{ failures}} = 25.43 \text{ hours}$$

$$\text{MTTR} = \frac{\text{Downtime (hours)}}{\text{\# failures}} = \frac{64.65 \text{ hours}}{66 \text{ failures}} = 0.98 \text{ hours}$$

- Automated evaluation of most important KPI's for production effectiveness
- Mean time to repair and Meantime between failure based on downtime tracking

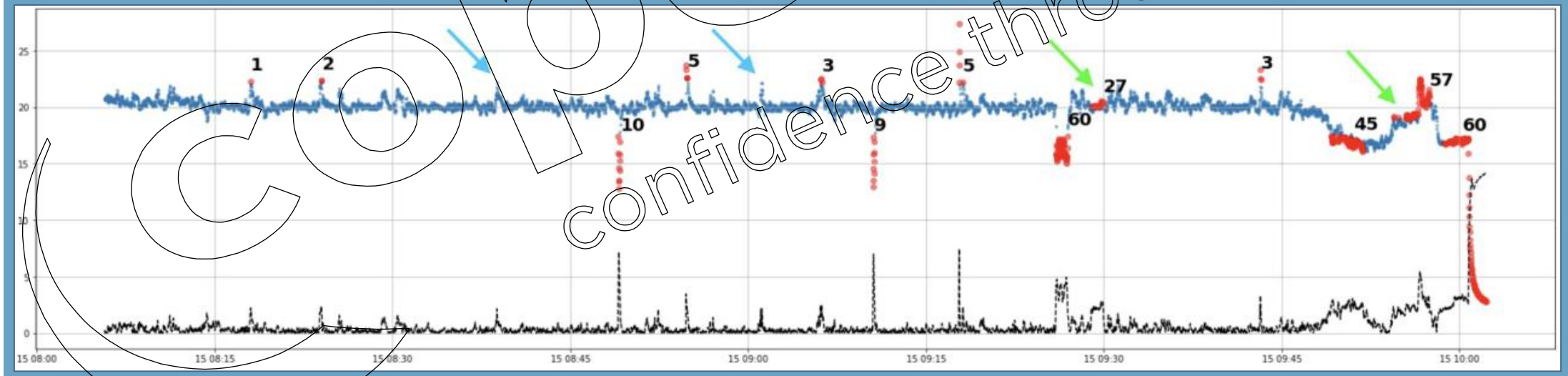
Data Based Process Monitoring

AI algorithm trained on machine data

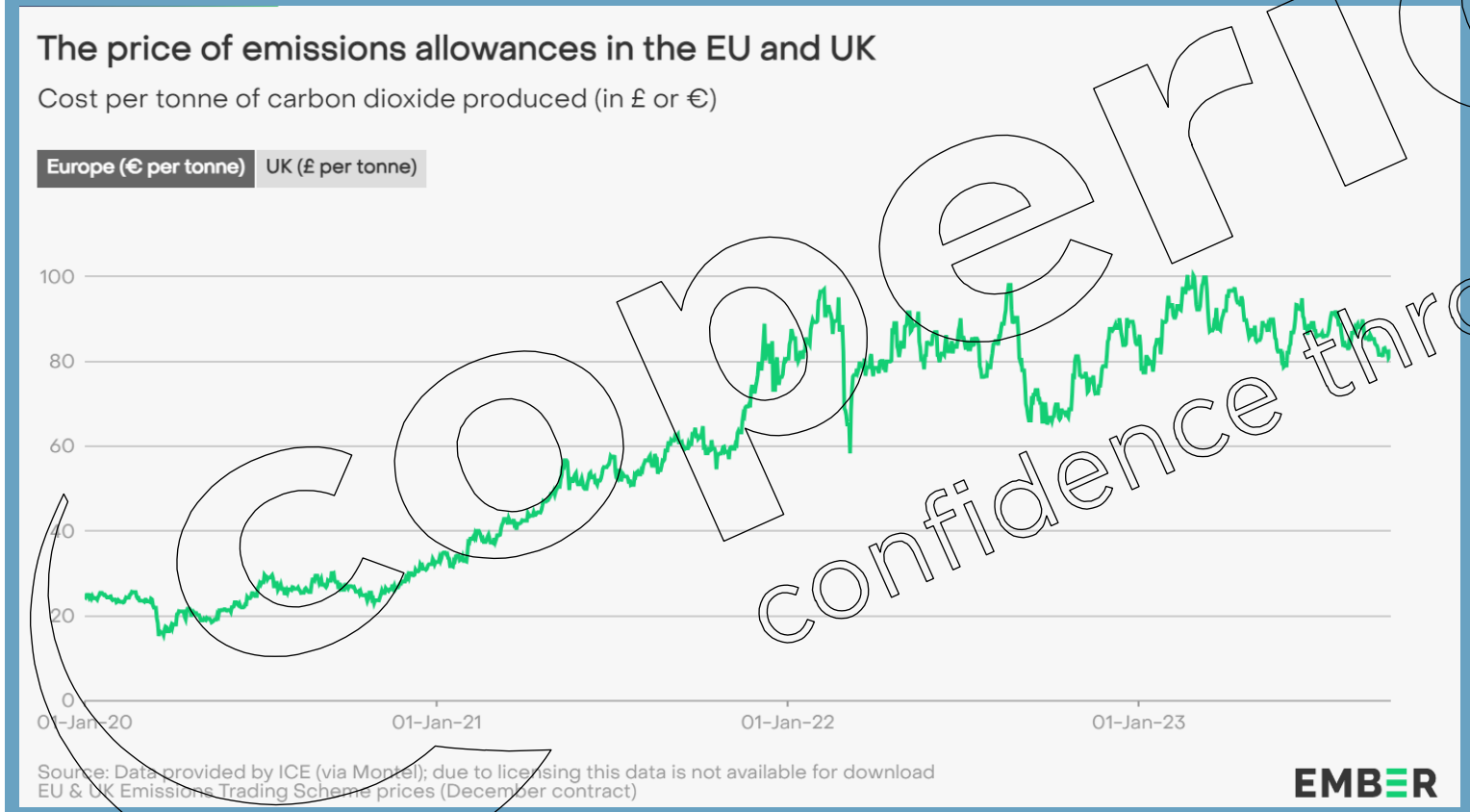
Realtime process evaluation

- Analyzing multiple signals in realtime
- Classifying of anomalies by a trained algorithm into different categories

- Indicates process stability and product quality
- Quick reaction to process deviations to avoid waste
- Automated machine actions, like emergency stop to prevent breakdowns



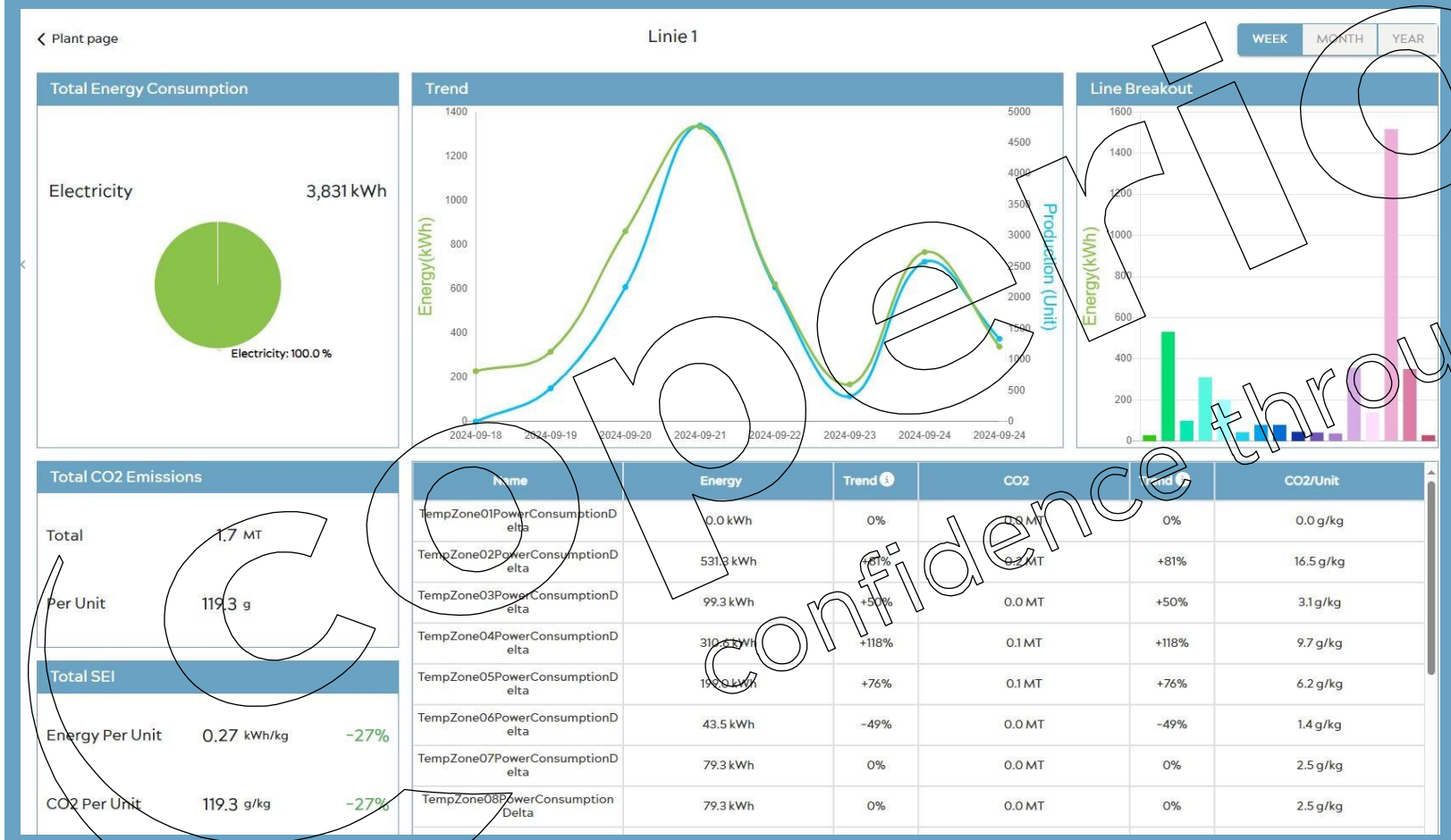
Energy Monitoring – Why Is It Important?

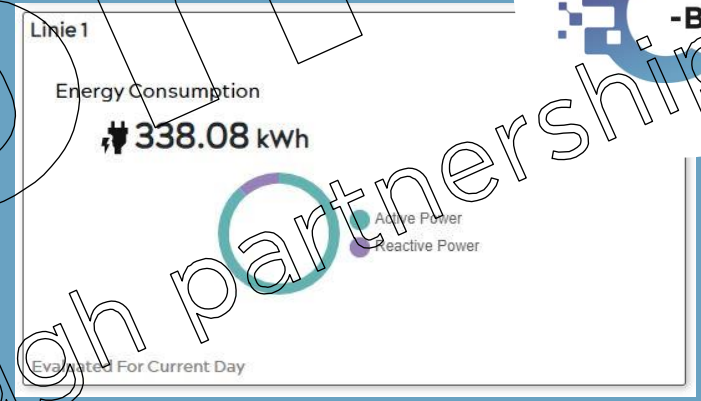


- CO_2 prices are increasing significantly
- An increasing number of countries introduce CO_2 taxes or emission trading systems
- More and more countries give a financial bonus for energy saving

Energy Monitoring

Optimize your processes for optimal performance





- Measure, calculate and report KPI numbers
- Validate consumption trends over time
- make efficient use of resources and reduce costs

Thank you!

Tanja Karrer
Automation & Control | Coperion

Markus Schmudde
Head of R&D | Coperion

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