

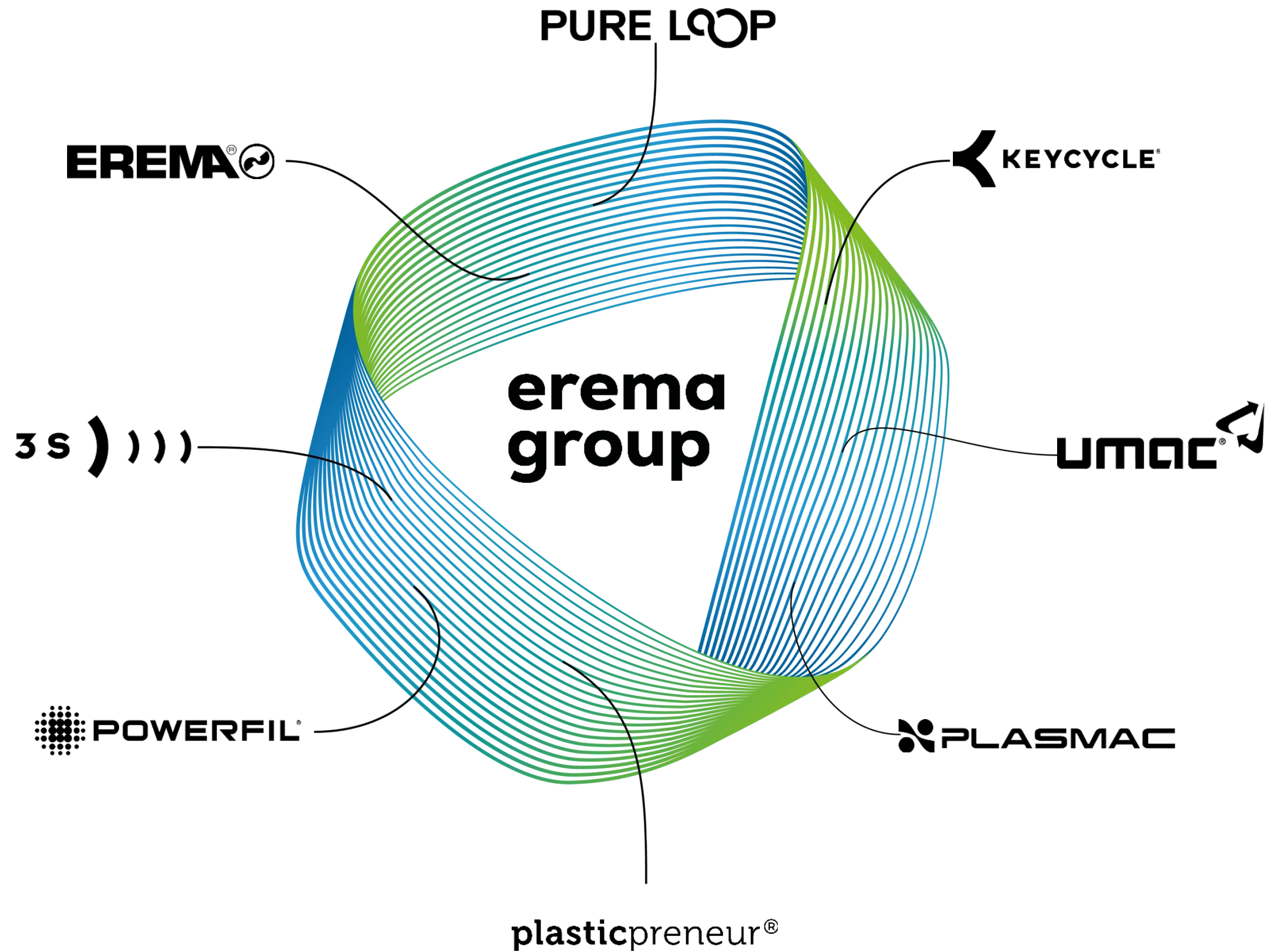
Input Stream Definition for Chemical Recycling Plants

Klaus Lederer
Technical Research Manager Chemical Recycling
Ansfelden, 07.2022

EREMA Group

840 Employees
Turnover **€M 295**
(fiscal year 2021/22)

A **very comprehensive portfolio** of plastic recycling solutions.



Click on the company for more information!



More than 7,500 Worldwide.
Total capacity: 18.5 Mio. t



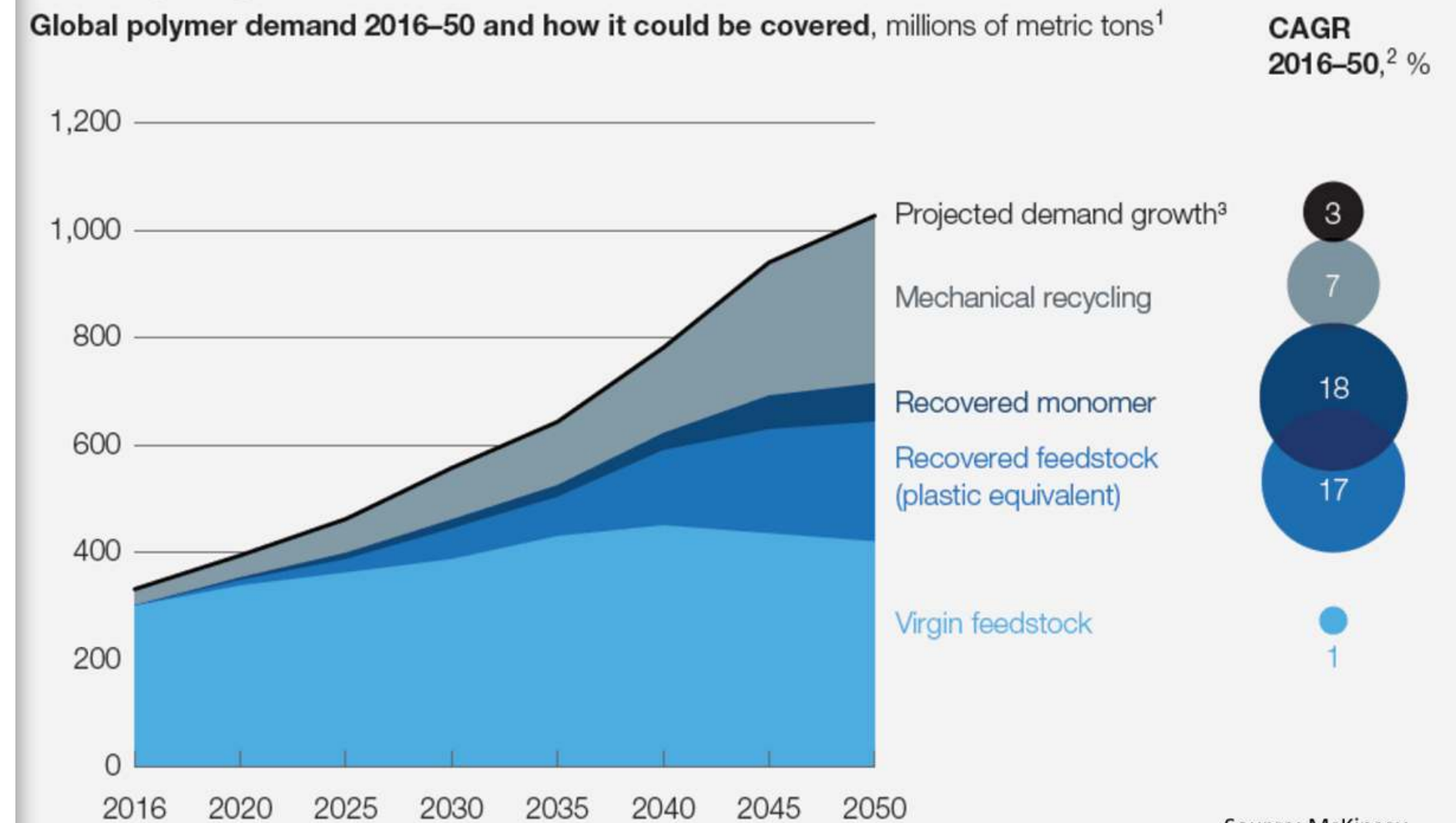
Plastic Recycling Systems
EREMA Group is the global market leader

[more info](#)

The plastic problem is only about to start

World plastic consumption estimated 460 million tons in 2030 (2020: 360 million tons)

By 2050, nearly 60 percent of plastics production could be based on plastics reuse and recycling.



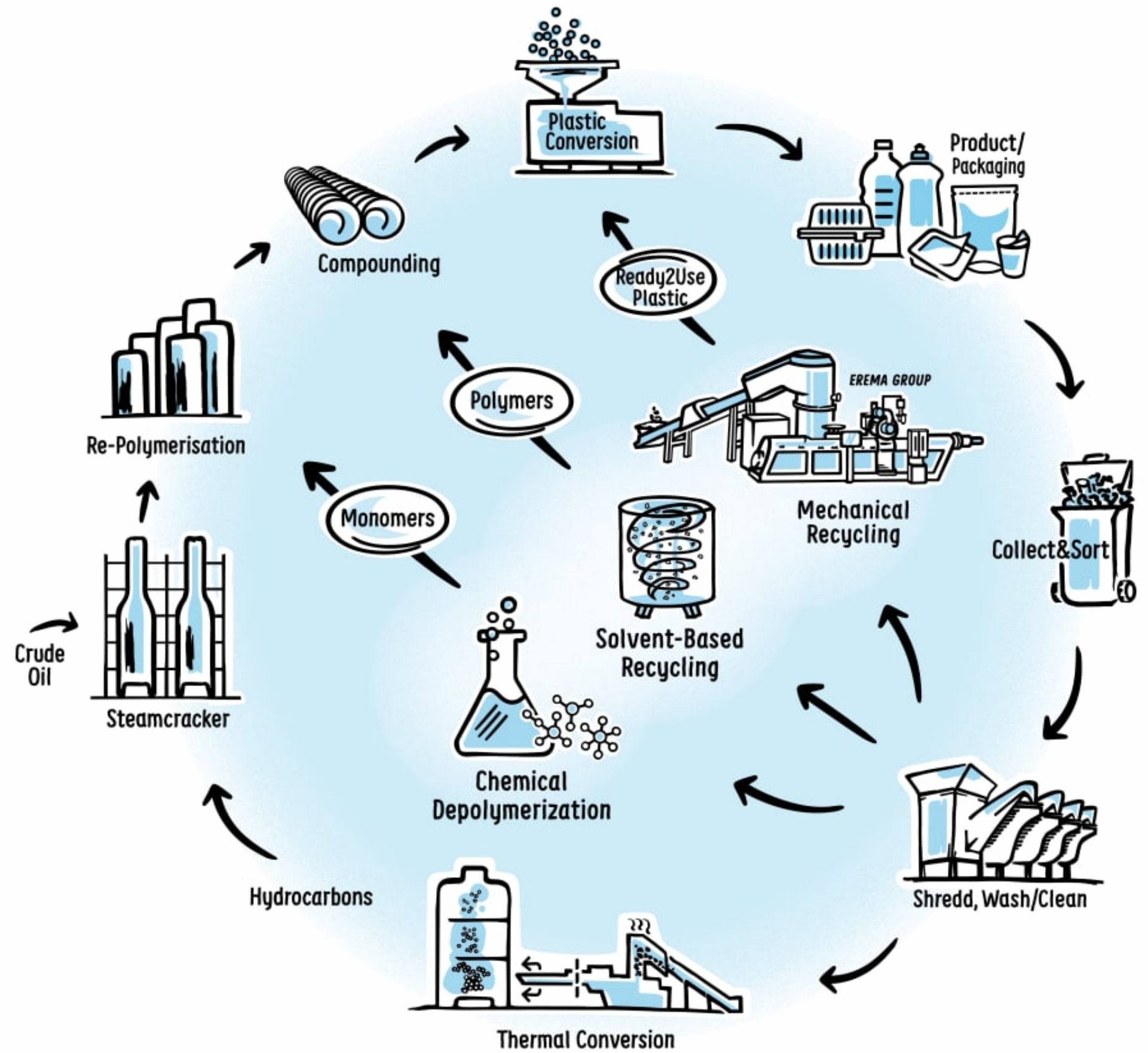
Erema Group: a strong partner for Chemical Recyclers...

... providing expertise to advanced recycling from local start-ups to global petrochemical majors.

...inputstream preparation units supplied to Japan, UK, Austria, Spain, Canada, Hungary, USA..

...contributing to projects in:

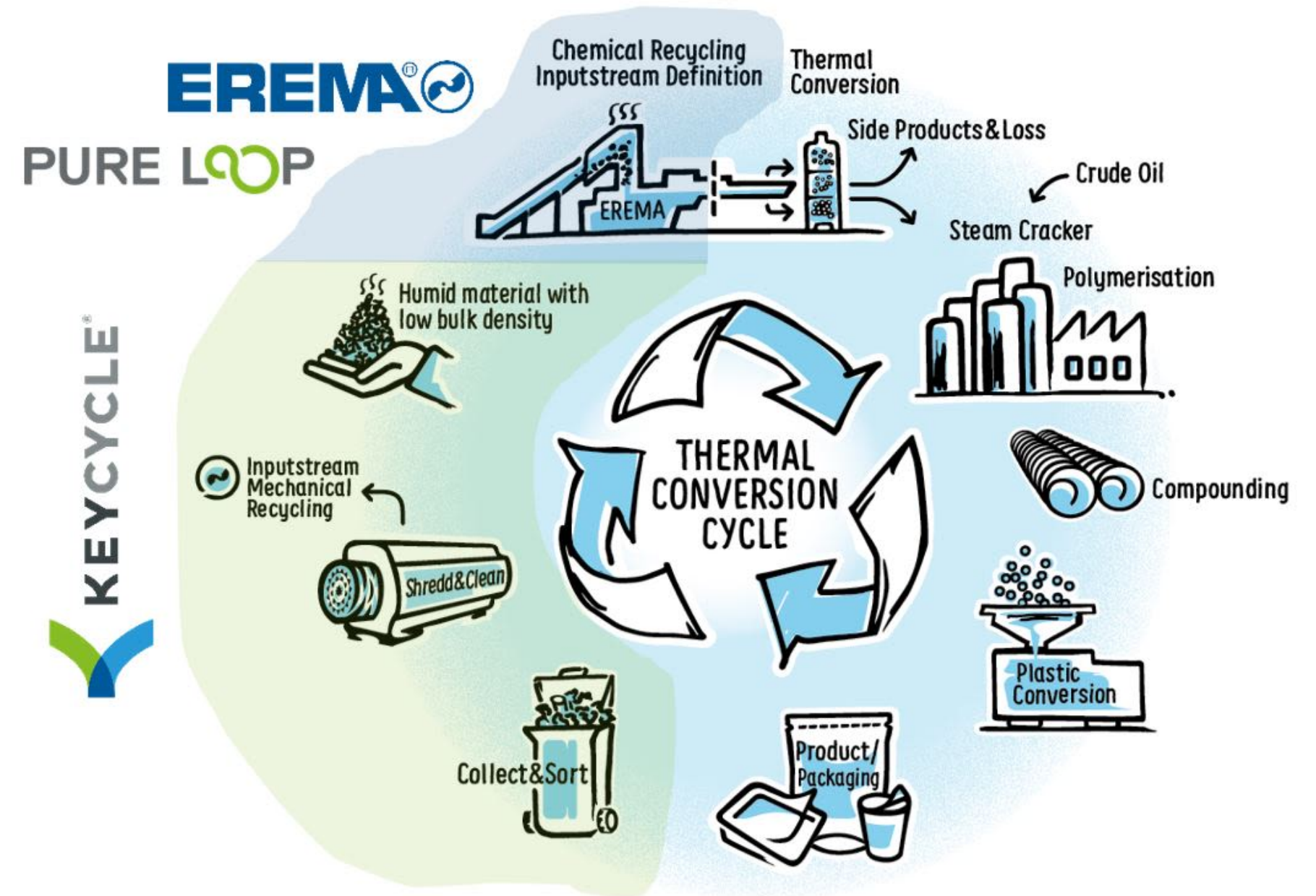
- Solvent-Based Purification
- Chemical Depolymerization
- Thermal Conversion / Pyrolysis
- Deinking



EREMA Contribution to Chemical Recycling

Example: Thermal Conversion

- **Extrusion based inputstream preparation**
- **All-In Material Preparation Units** ("from bale to reactor")



The Chemical Recycling Input Stream Challenge

How to introduce **moist, low-bulk-density** and **heterogeneous Post Consumer Plastic waste** **oxygen-free, scalable, reliable and energy-efficient** into a Chemical Recycling Reactor?

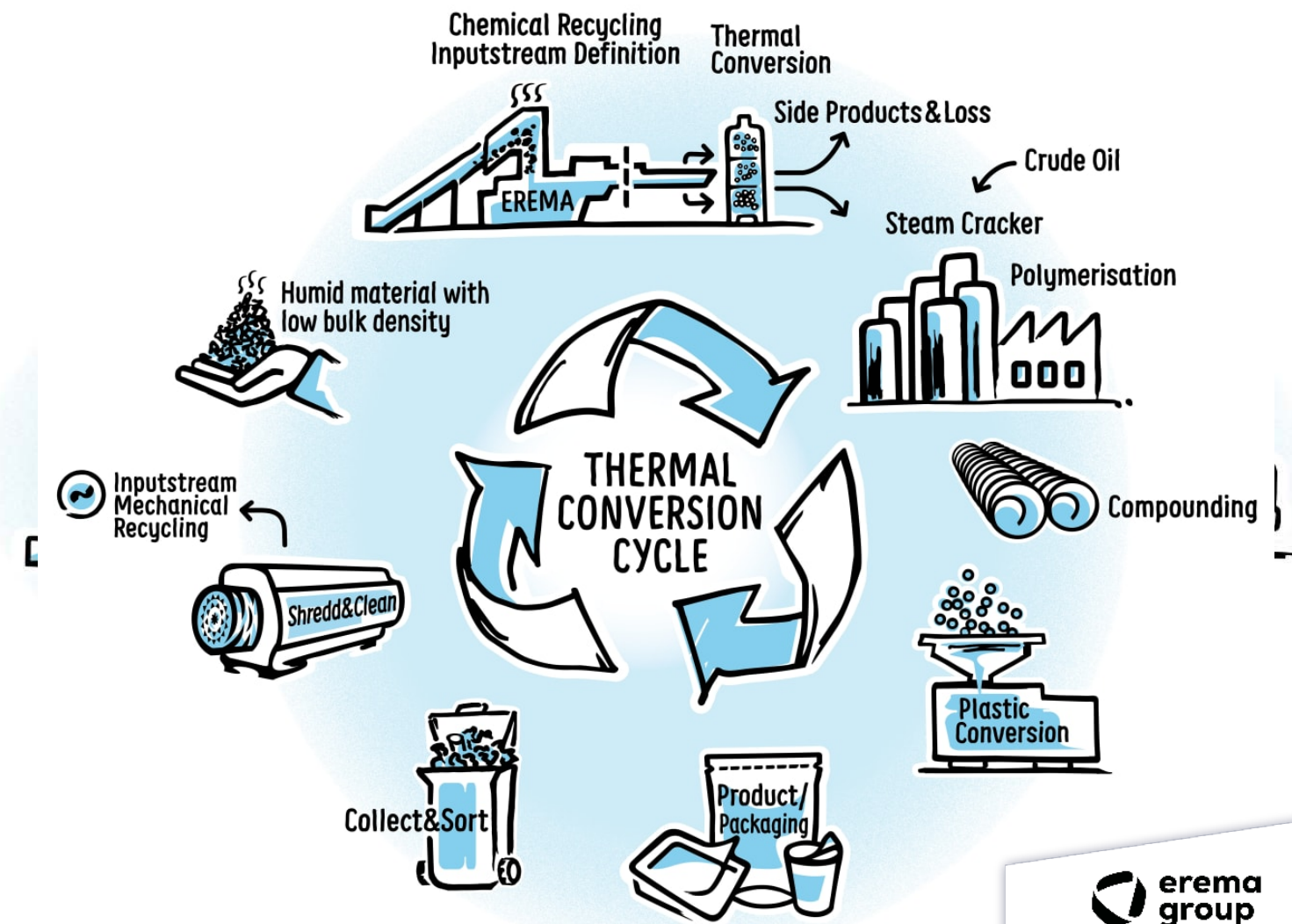
? DIRECT REACTOR FEED (cold flakes):

- problematic feeding of low bulk density waste
- difficult inertisation
- difficult upscaling (heating of feedstock in reactor as bottleneck)

? CONVENTIONAL EXTRUSION (single or twinscrew):

- requires predrying and pre-compaction to 250 kg/m³ (~ 15 lb/ft³)
- lost energy from multiple heating steps not available for the reactor

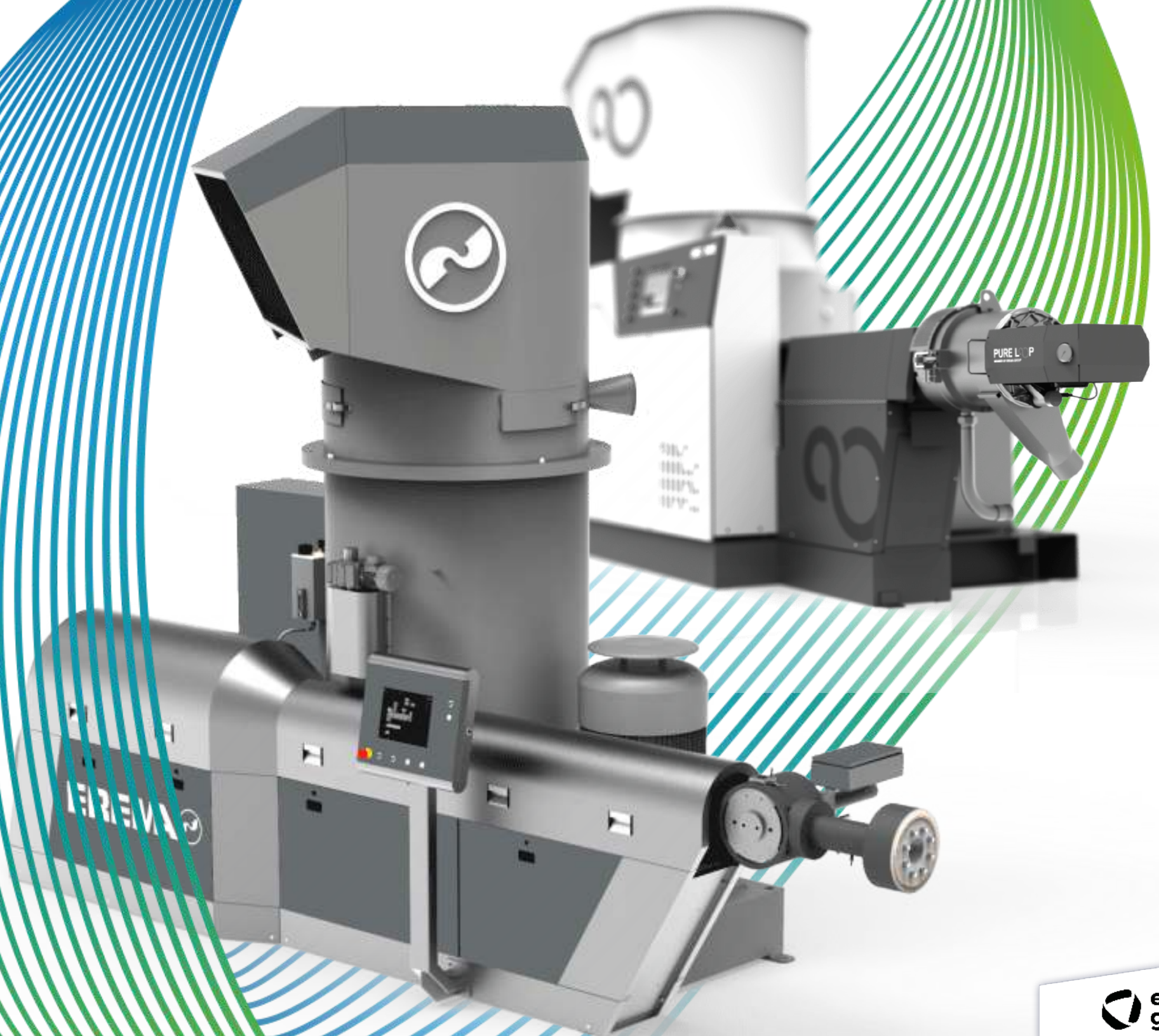
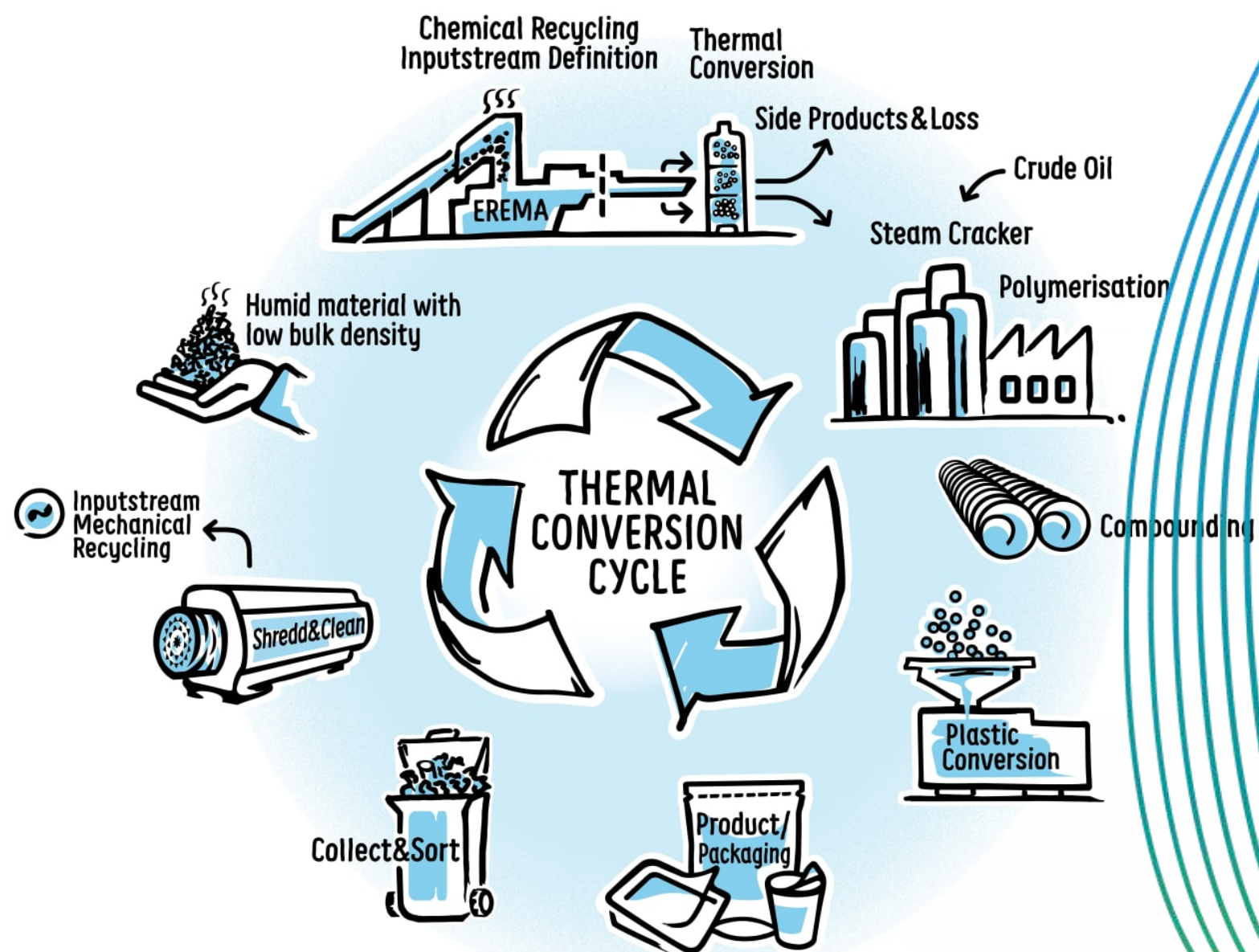
! **THE OPTIMAL SOLUTION is industrially proven** to dry and melt low bulk density materials and/or solids and forwards into the reactor in one single step ("1 Heat").



CHEMAREMA[®] and CHEMAREMA[®] SE

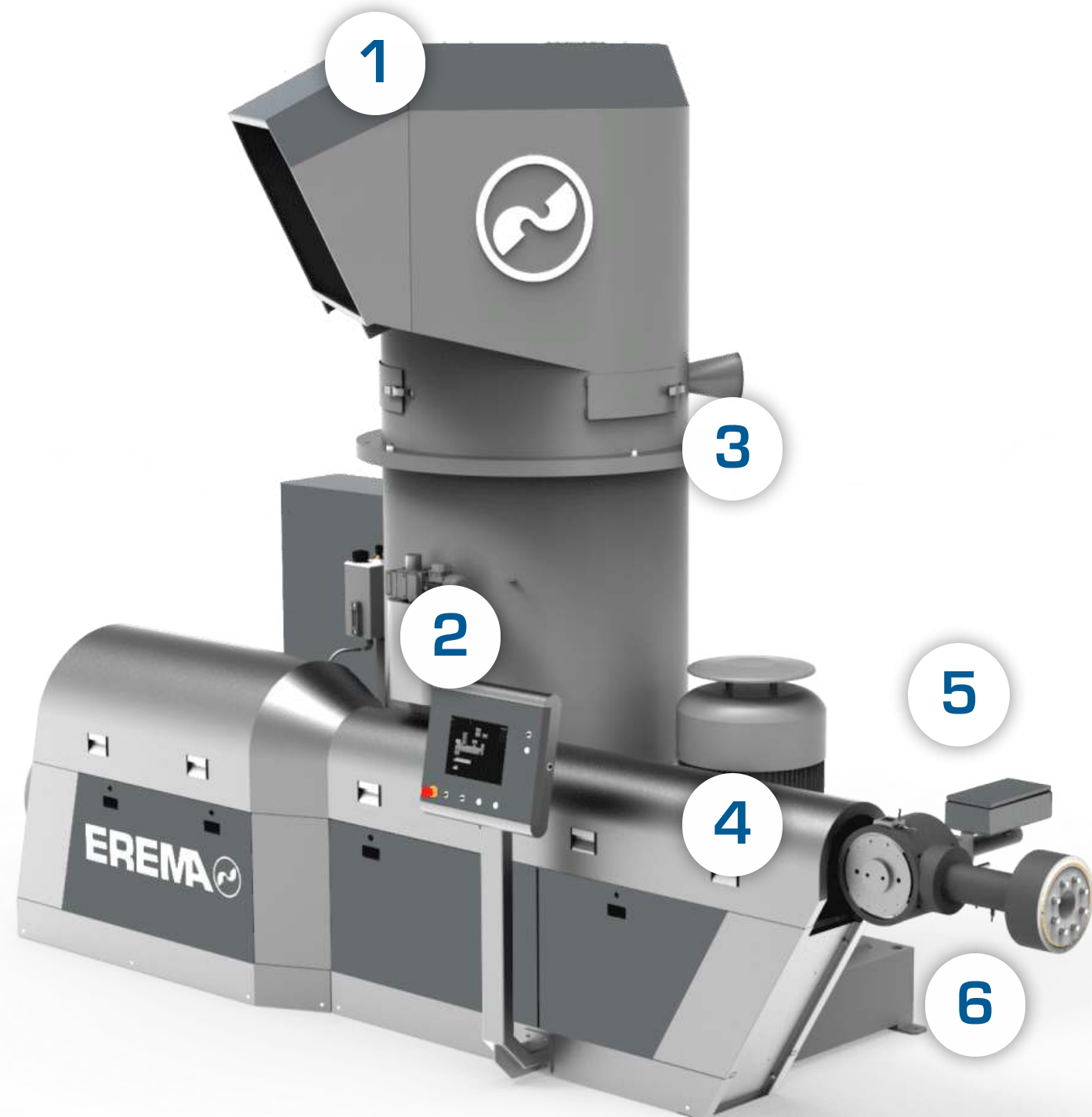
Input Stream Preparation for Chemical Recycling

Example: Thermal Conversion



CHEMAREMA[®]

Preconditioning Unit Singlescrew Extrusion



- 1 Pre-Conditioning Unit (PCU) *
 - cuts, heats, homogenises, compacts, dries, buffers, doses
 - 1000x proven Solution for PCR Films & Flakes
 - 2 PCU Counter Current Technology*
 - 3x wider process window
 - 30% higher throughput
 - flexible input (film, flakes, rigids, pellets)
 - 3
 - shock- and overheat protection (PCU)
 - "QualityOn" Online Composition Analysis
 - 4 Single-screw Extrusion*
 - compact and efficient. up to 300bar.
 - THE proven technology for PCW!
 - 5 Meltdiverter valve
 - 6 Reactor Handover via Meltpipe (p, T, Visc.)
- *Optional: armouring and design for high abrasive materials



cuts



homogenises



heats



dries



compacts



buffers



doses



The Preconditioning Unit

One machine - many functions



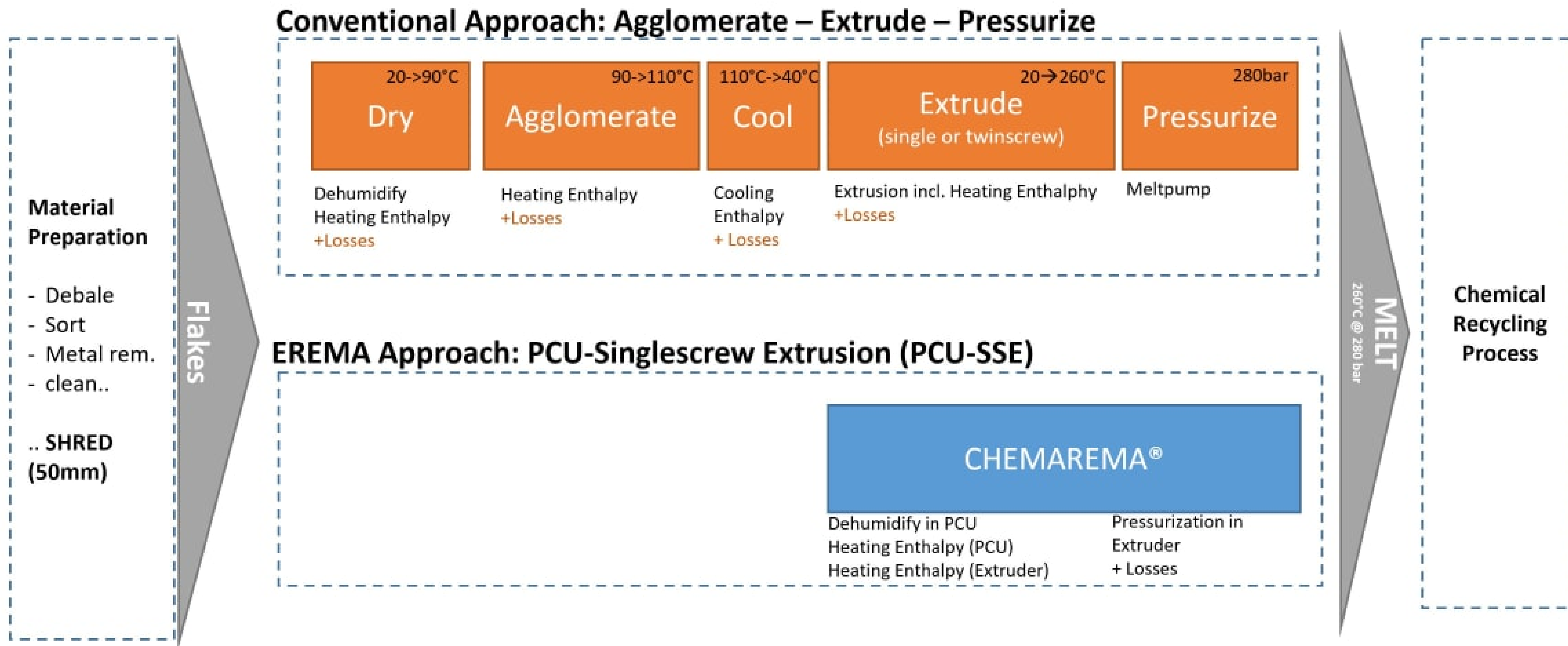


Material Preparation for Chemical Recycling

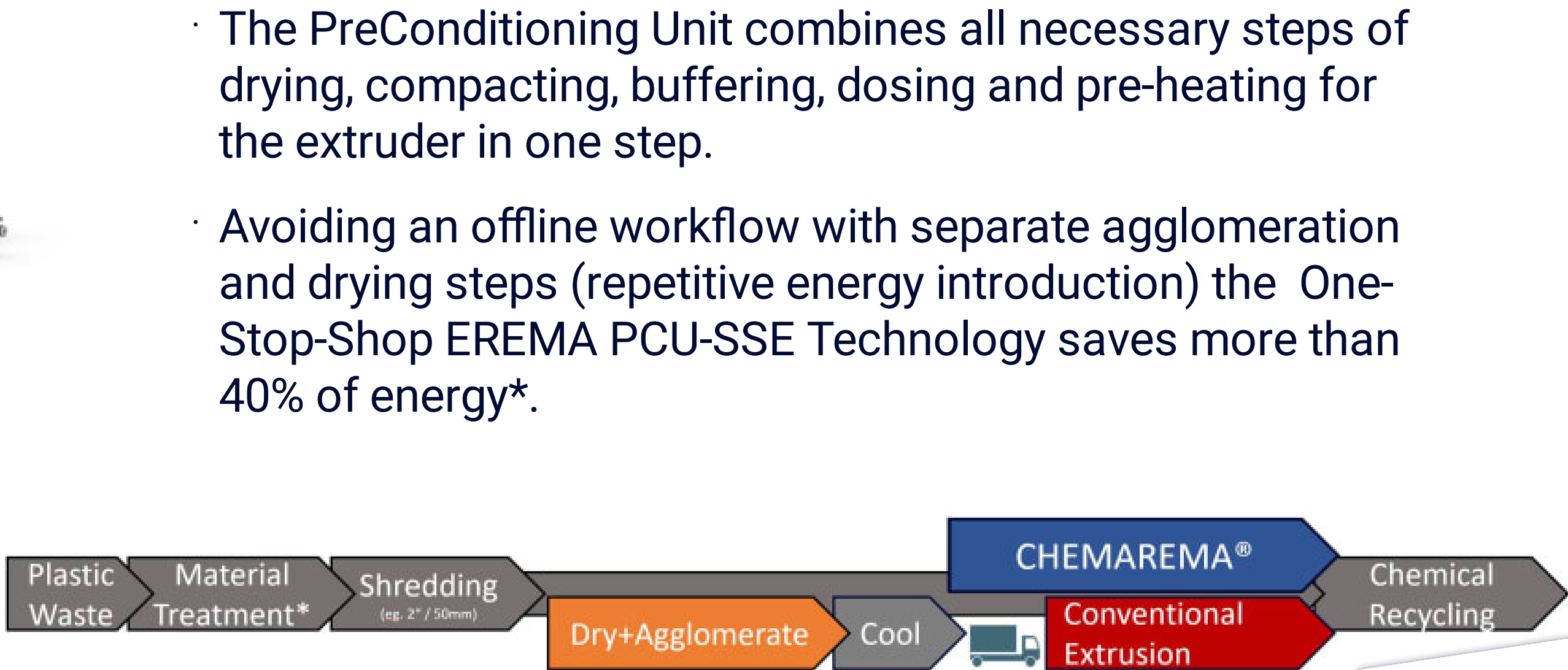
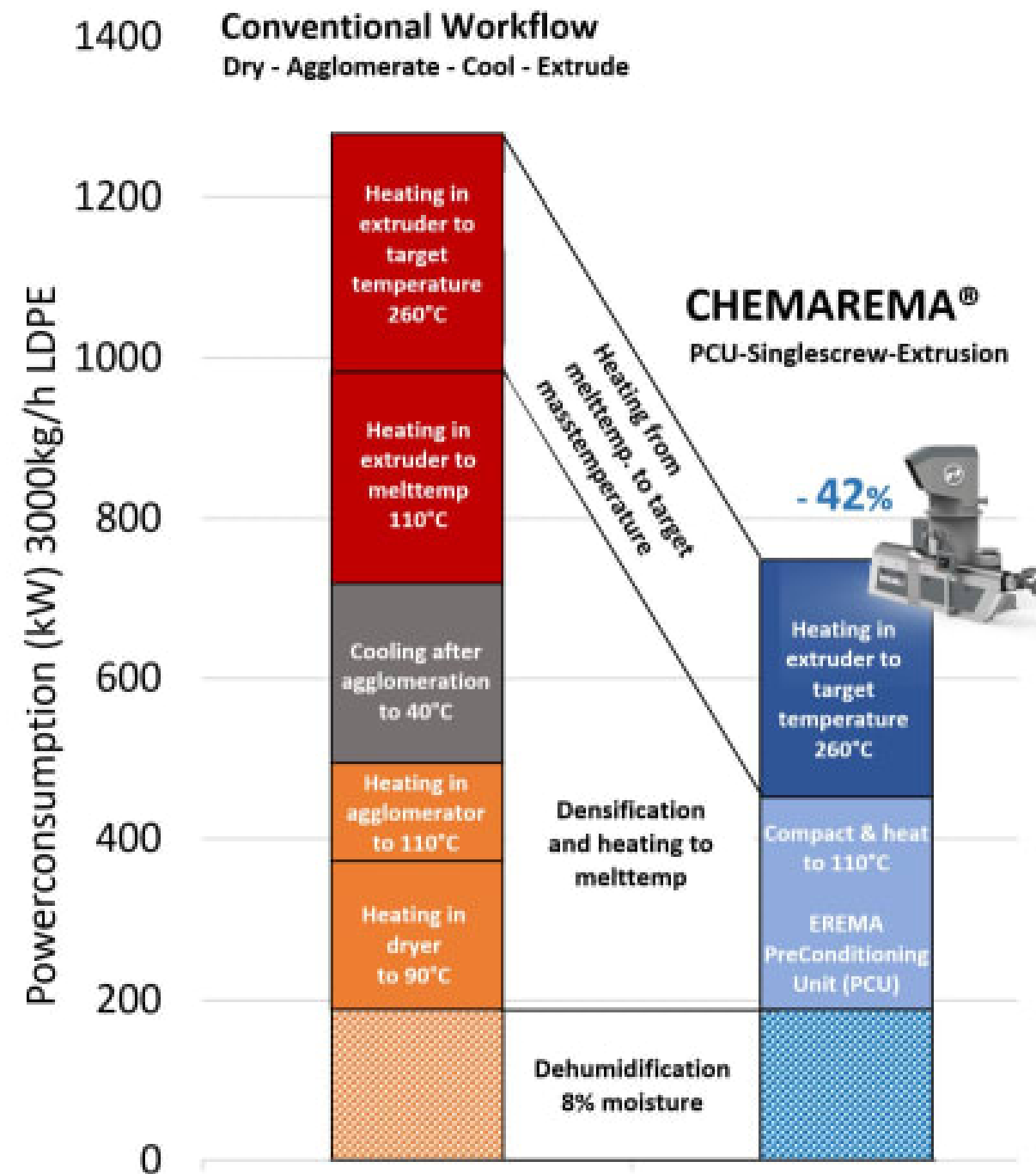
**Energy Efficiency Comparison
Conventional Extrusion vs. CHEMAREMA PCU-Singlescrew**

Energyefficiency CHEMAREMA vs. Conventional approach

INPUT: LDPE, 8% moisture / OUTPUT: Melt @260°C / 290 bar



40% energysavings of EREMA One-Stop-Shop Solution vs. conventional workflow (only enthalpies, no losses)



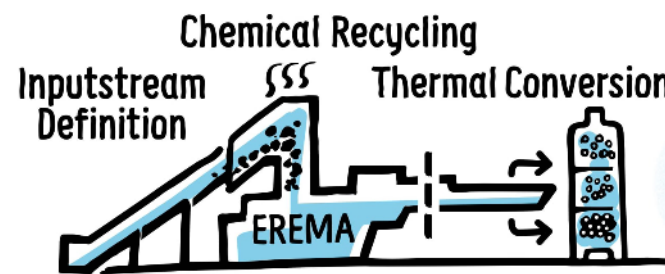
- The PreConditioning Unit combines all necessary steps of drying, compacting, buffering, dosing and pre-heating for the extruder in one step.
- Avoiding an offline workflow with separate agglomeration and drying steps (repetitive energy introduction) the One-Stop-Shop EREMA PCU-SSE Technology saves more than 40% of energy*.

* Energy calculation only from enthalpy for heating and cooling of LDPE. No Losses.

Technology Comparison

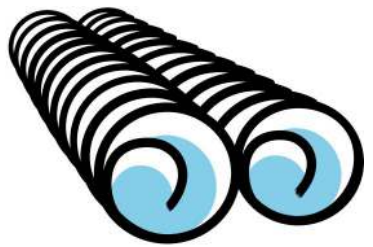
Single screw extrusion vs. twin screw extrusion

Advantages & Risks of PCU-single screw extrusion



- Excellent **pressure build-up** (no melt pump necessary)
- Single screw less critical for **contamination**
- Designed to feed very **low bulk densities** (e.g 50 kg/m³ or 3 lb/ft³, mixing with pellets no problem)
- Maximum **energy efficiency** (one stop shop inputstream preparation)
- **Moisture removal** up to 8%
- maximum **process stability** by Countercurrent Pre-Conditioning Unit
- Post Consumer Plastics Extrusion at **Scale** (up to 5 to/h, Erema is market leader)
- High mass temperatures (>280°C) and pressures (>250 bar) possible, but may influence capacity

Advantages & Risks of twin screw extrusion



- High pressures require **additional melt pump** (high wear)
 - a melt pump **requires additional protection via melt-filtration** --> additional challenge on pressure demand
- **Mechanical wear** of self-cleaning corotating twin screws
- Low bulk densities additional material **pretreatment needed (e.g. agglomeration step)**
- For feed moisture contents larger 3% additional material **pretreatment needed (e.g. predrying)**
- No homogenisation step due to missing PreConditioning Unit
- **High outputs possible > 5 to/h**
- One large machine possible vs. safety and practicability of 2-3 smaller machines (logistics, CAPEX, OPEX, availability,...)
- High mass temperatures and high output capacities possible but increasing rpm will increase abrasive wear.

Chemical Recycling will open a new dimension of scale.

EREMA PreConditioning Technology combined with single-screw extrusion defines the input stream for chemical recycling systems.

Now delivering outputs of 5 tons per hour.



Example: PET recycling powered by a 280mm single



*including machines currently in construction



**Chemical Recycling
Input Stream Preparation Systems**
> 20 machines sold worldwide

[more info](#)

Summary

Prevent, Reduce, Reuse

Mechanical Material Recycling
and solvent-based purification

Chemical Feedstock Recycling

Energy Recovery

Incineration

Landfill

a

Chemical Recycling as complementary technology for materials that today cannot be recycled and would otherwise be landfilled or incinerated.

b

The EREMA Group offers and develops a strong toolbox of technologies and services for the chemical recycling industry:

- PCU Singlescrew Extruder (CHEMAREMA®)
- Integrated Shredder Extruder (CHEMAREMA® SE)
- Vacuum Support solutions (CHEMAREMA® VAC)
- Turnkey Materialpreparation Units (KEYCYCLE)

c

For Thermal Conversion the CHEMAREMA Preconditioning Unit Single Screw Extruder (PCU-SSE) is the technology of choice for robust, energy efficient material preparation at scale.

d

Significant Energy advantage of PCU-SSE when compared to conventional extrusion that requires additional offline material compaction

e

Latest member of the EREMA Product family achieving throughputs up to 6 t/h.