

Demonstrating the Industrial Scale Feasibility of Chemical Recycling in Germany

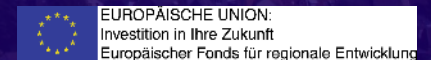
Julian Odenthal (ARCUS Greencycling Technologies GmbH)
13th May, 2022



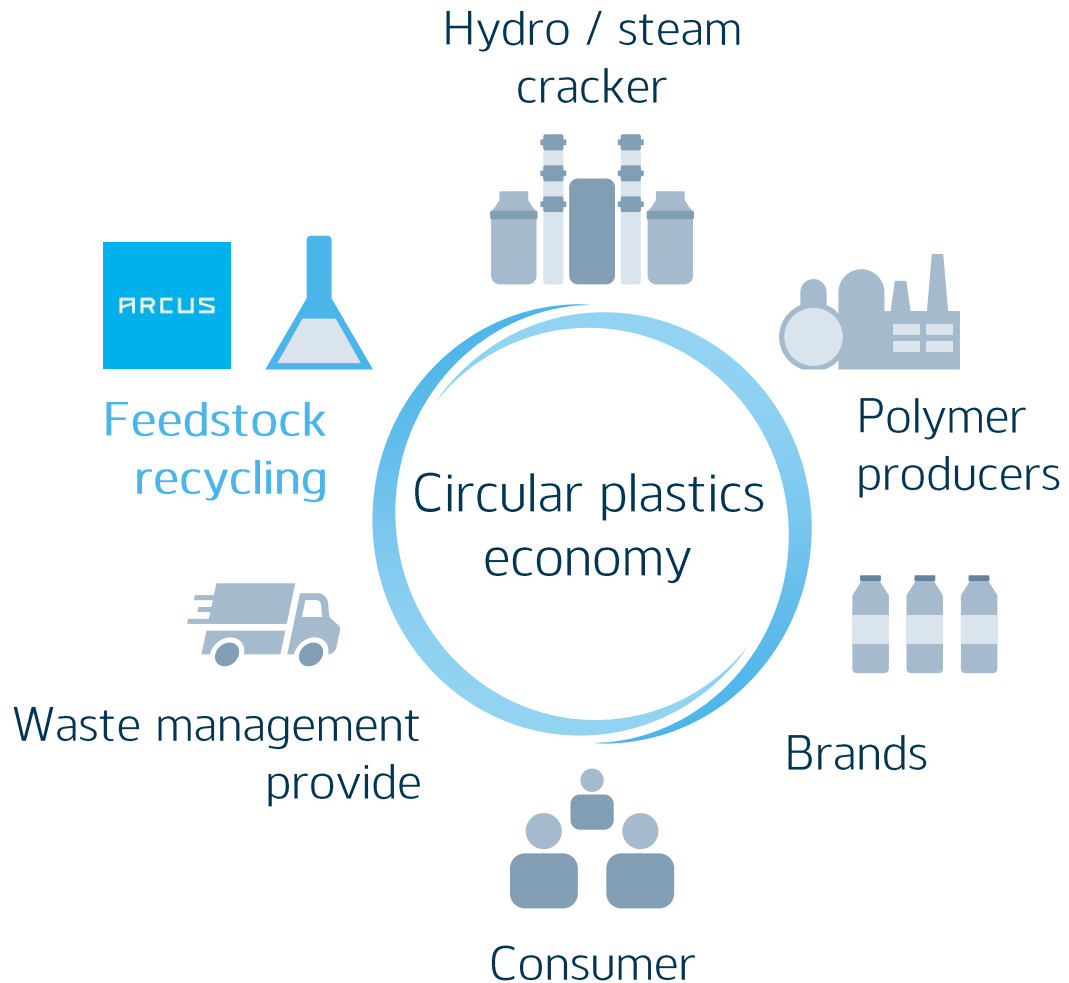
**Process⁴
Sustainability**

**Cluster for climate-neutral
process industries in Hesse**

Supported by:



ARCUS enables the circular plastics economy with an interdisciplinary team and strong partnerships









Founded 2016

Status quo

- Stable pyrolysis process at benchscale reactor
- Industrial scale Process Demonstration Unit (PDU) (4000t/a) currently in construction
- Cooperation along the plastics value chain currently in development

Core team

- | | | | |
|---|-----------------|---|--------------------------|
|  | Markus Klatte |  | Dr. Marco Tomasi Morgano |
|  | Ralf Reichardt |  | Paulina Dyczewska |
|  | Daniel Odenthal |  | Julian Odenthal |

Plastics are and will remain an important material – therefore we need to close “the plastic loop”

Plastics Pile Up as China Refuses to Take the West’s Recycling

Officials in Britain and the West are scrambling to cope with growing piles of plastics like this one in China. Beijing banned the import of many recyclables on Jan.1. Fred Dufour/Agence France-Presse — Getty Images

Source: The New York

The next plastics boom could be around the corner

Source: Plastic News, Bill Wood, 11.07.2017

World’s plastic waste could bury Manhattan 2 miles deep

By Seth Borenstein The Associated Press

Source: Global News, 19.07.2017

Science & Environment

Plastic waste 'building up' in Arctic

By Roger Harrabin
BBC environment analyst

Source: BBC News, Science & Environment, 08.02.2018



Global economy is only ~9% circular



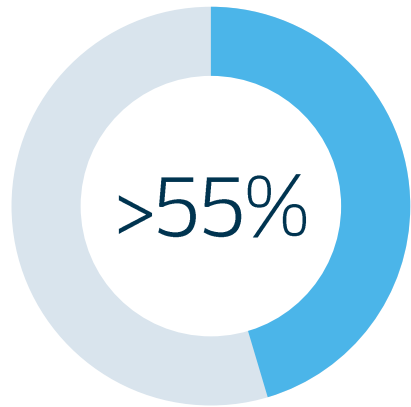
~33% of post-consumer plastic waste are recycled, but recyclates only cover ~8% of plastics demand



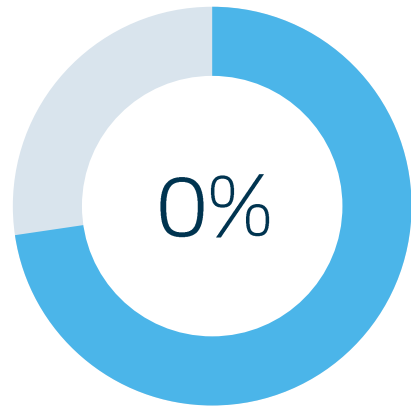
Germany recycles ~39% of post-consumer plastic waste – the remainder is incinerated

EU has set itself highly ambitious targets for 2030...

Mid term goals (2025 / 30)



...of all **plastic packaging waste** recycled

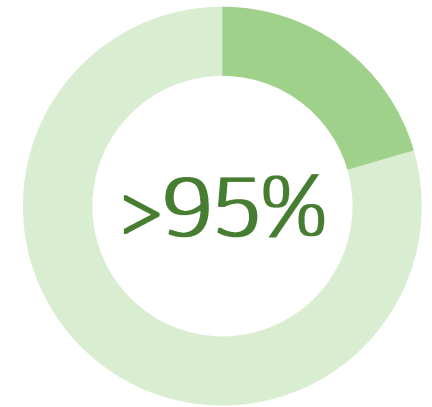


...of '**recyclable waste**' landfilled



...of **recycled plastics** find their way into **new products** (by 2025)

Long term goal (2050)



...of all **plastics waste** should be '**meaningfully**' recycled in a truly circular economy

 Current achievement level compared to target in absolute figures

...that can only be achieved by 'joining forces' along the value chain

FOCUS



Product design

Recycling friendly product design



Collection rate

Higher collection rate



Sorting capabilities

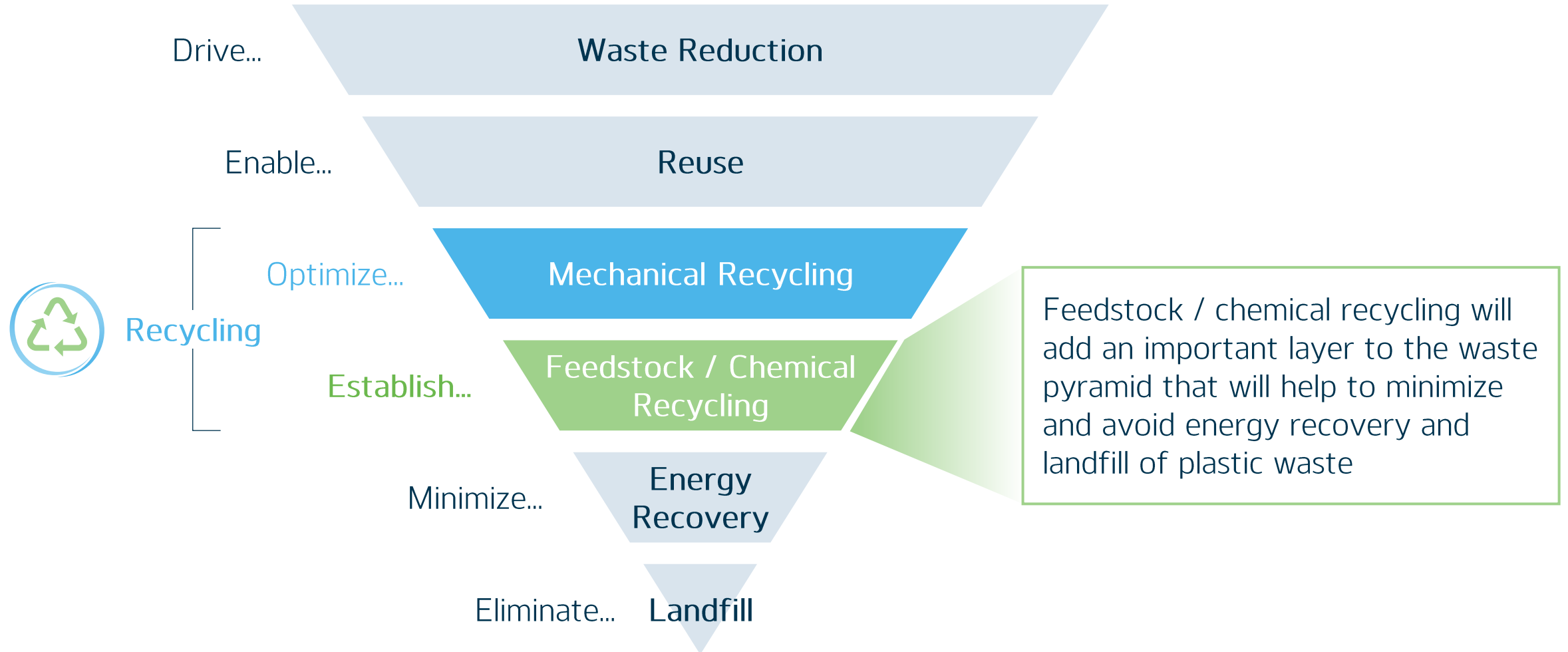
More and higher quality sorting capabilities



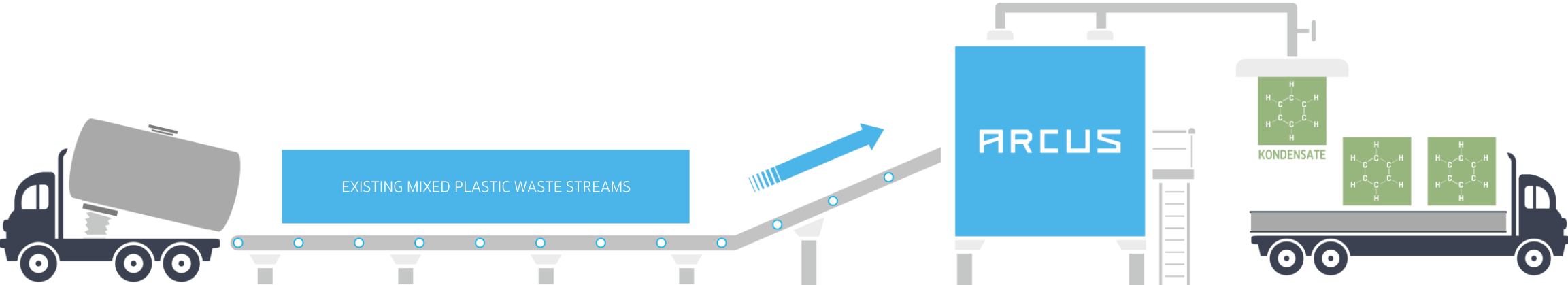
Recycling capabilities

More and diverse recycling capabilities (i.e. both mechanical and chemical recycling)

Establishing feedstock / chemical recycling will be critical in reaching the targets



ARCUS-technology recycles existing waste streams into “in-spec” pyrolysis oil for the petrochemical industry



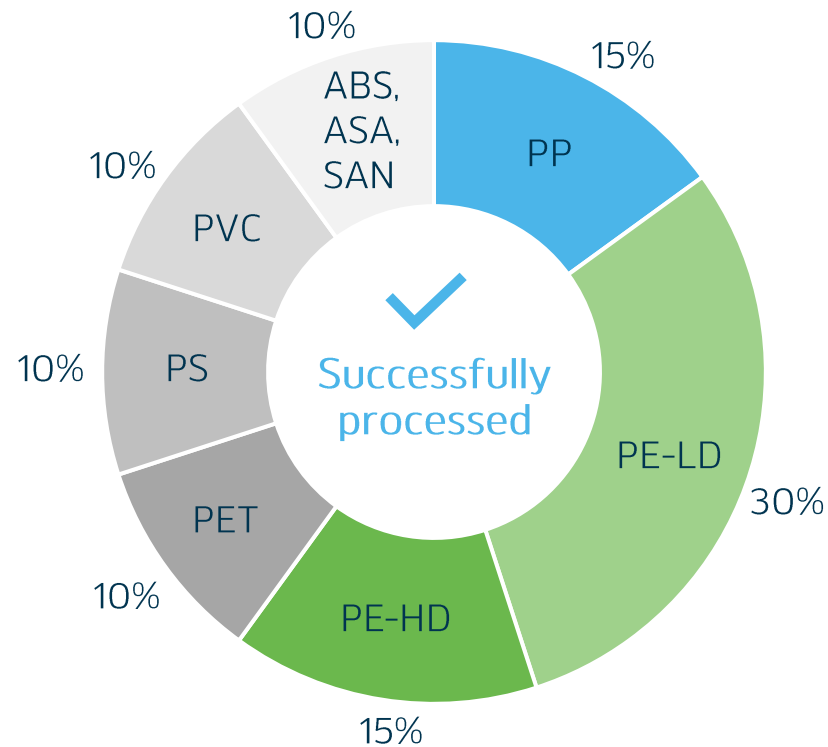
Existing currently incinerated **waste streams** without secondary pre-sorting

Close to **energy-self-sufficient** pyrolysis process circulating operating media

'In-spec' oil, usable gas and environmentally harmless solids

We believe that pyrolysis needs to be able to handle heterogeneous and contaminated plastic waste – our process is highly robust

- Waste is heterogeneous, always mixed and varies by day and season
- Therefore we believe that **pyrolysis** needs to be able to handle contaminated waste without secondary sorting
- This maximizes recycling rates and minimises CAPEX / OPEX in the supply chain



- Therefore we have designed our technology and process to be as **robust as possible**
- At **bench scale** we have been able to process **highly contaminated feedstocks**
- We will be able to handle existing waste streams **without any further sorting / washing**

We will be able to verify and fine-tune our process in an industrial scale at the end of this year

Key facts



Input
0.5 t/h



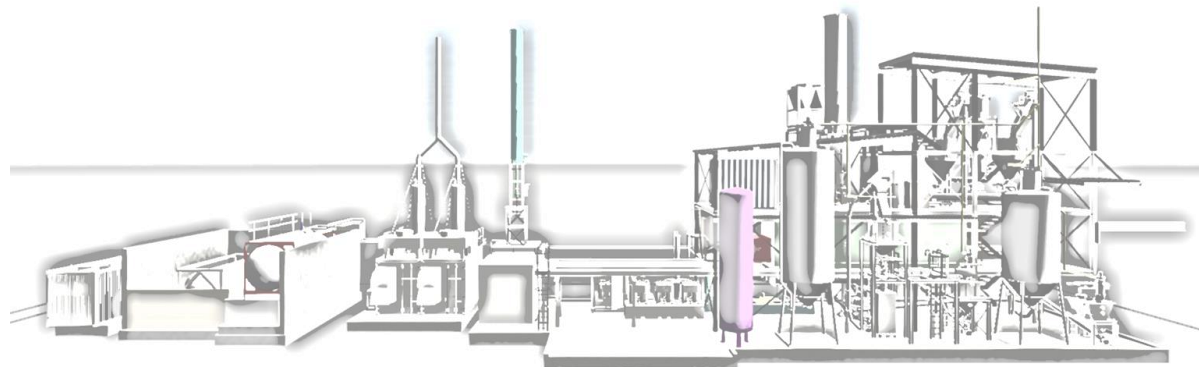
Output
~0.33 t/h

Highlights

- ✓ Flexible and robust against variable feedstock content and contamination
- ✓ Fully closed mass-balance possible
- ✓ Minimal primary energy consumption and circulating operating media
- ✓ Existing LCA and proven ecological benefits

Status quo

- Regulatory approval process nearly completed
- Start of construction in Q2 2021
- Targeted completion end of Q2 2022
- Following completion timely further development and roll-out of ARCUS technology



ARCUS plant in Höchst is the **first and currently only fully approved plant** of its kind in Germany (approval duration ~14 months)

Generally, feedstock / chemical recycling...

... enables recycling of currently **not-recyclable waste streams**

... enables a **truly circular plastics value chain**, independently of prior and future application

... **increases use cases** for recycled plastics, especially in high performance industries

... is necessary to **cover increasing supply of and demand for** recycled plastics

... **substantially reduces fossil resource use** in plastic production and can create an 'oil field Europe'



We believe chemical recycling needs to play a crucial role besides mechanical recycling, if we want to achieve a circular economy and meet our targets

However, to fully unlock the positive impacts of chemical recycling there are several challenges to overcome



Close collaboration along the value chain with tangible efforts of all partners to “change” towards a circular economy for plastics



Higher level of understanding regarding waste streams and their composition (post-consumer, post-use industrial and post-industrial)



Standardized and dependably implemented (EU and national level) **legislative environment** (=investment security)



Supporting packaging legislation (VerpackG), that makes it easier to access relevant (currently incinerated) feedstocks (quality and quantity)



Carbon neutral energy supply as ARCUS technology is fully electric as well as **efficient logistics** for fully CO2 neutral operations

Contact

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