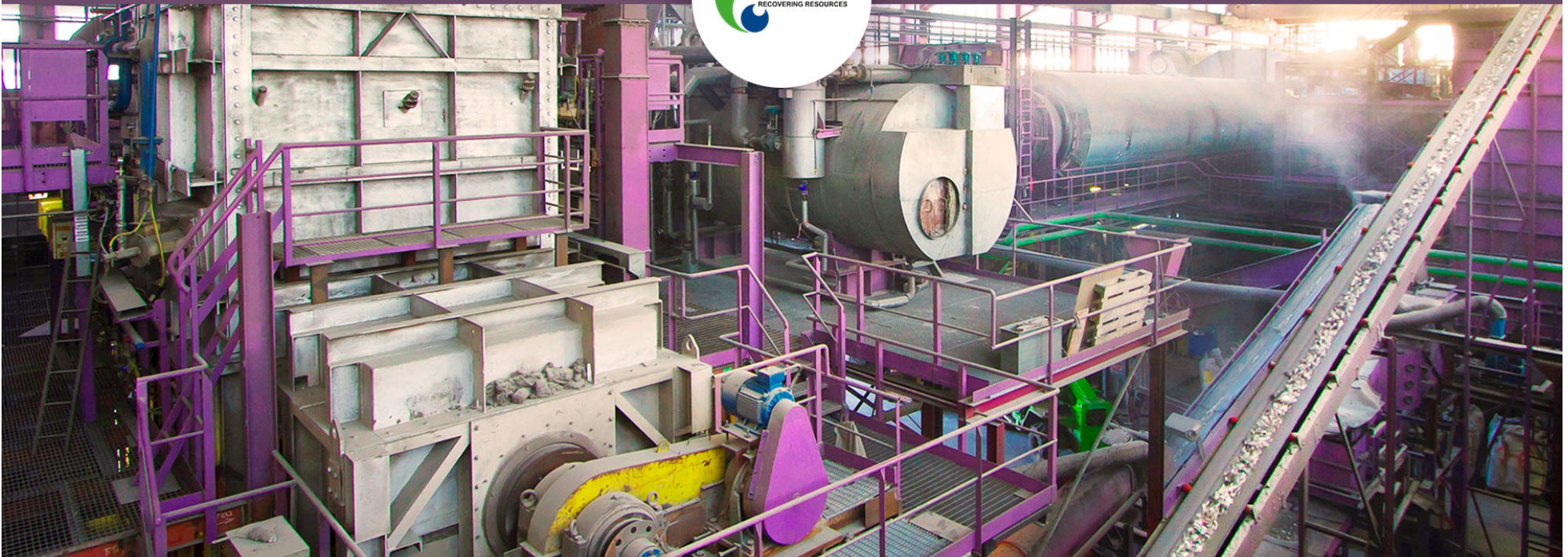


Optimized Sorting and Recycling short Life Time Products



Andreas Reissner
CEO PYRAL AG
29 June 2017



Who we are

PYRAL AG is an **innovative company**,
founded in 2005, located in Germany.



We stand for a
resource-recovering industrial policy
in connection with a
green environmental policy.



- Waste reduction is important, but equally important is to look at waste and see its **resource potential**
- Continuous **development and improvement** of our technologies for recovering the resources
- Processing of waste materials by **separation from organic and inorganic in the pyrolysis** instead of an ecologically less advantageous combustion in a waste incinerator plant
- Identification and separation of metal alloy to **completely close the loop**



What materials can the Pyrolysis recover?

Aluminium



- Packaging (Dinner tray, foil)
- Organic contaminated scrap
- ...

Non-Ferrous waste



- Copper-Bitumen-Mixture
- Cable
- ...

CFRP Wastes

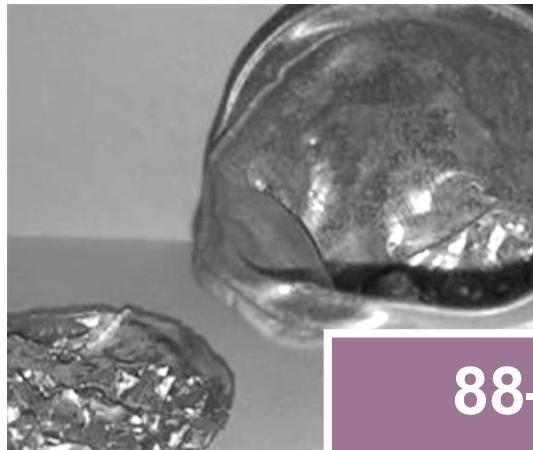
Carbon-fiber-reinforced-plastic



- Aviation industry
- Automotive industry
- ...



Aluminium Packaging



Pyralu[®]



88–90%
Smelting Recovery Rate

CFRP Product



- Constant, homogeneous quality of > 98% Aluminium Alloy purity
- Pyralu[®] is consistent in its quality and has 0% organic



Challenges of Aluminium Recycling

Heterogeneous and mixed material difficult to **collect**, **sort**, **separate**, **identify** and **recycle**.



Rigid Packaging



Semi-rigid Packaging

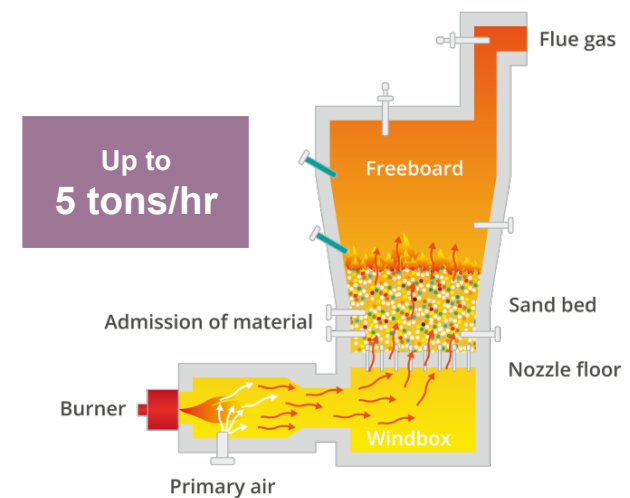


Flexible Packaging

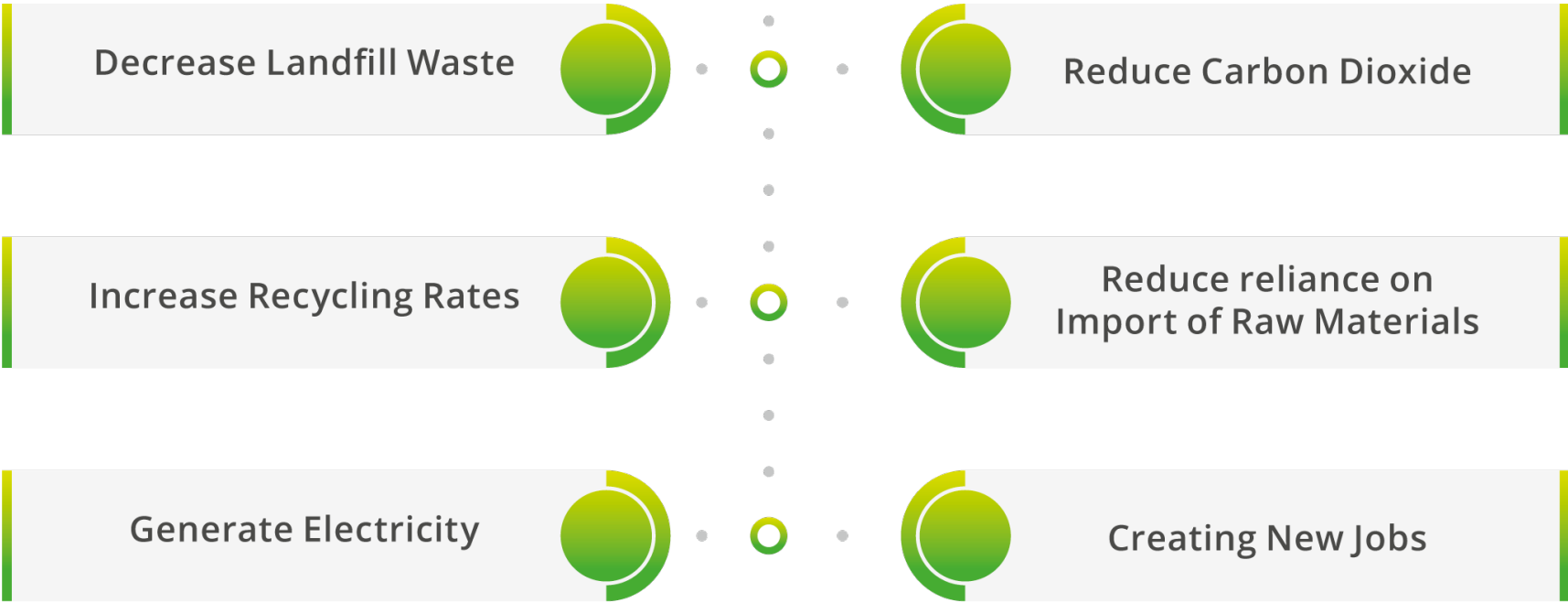


Why Pyrolysis?

- During incineration the raw materials **are completely combusted or destroyed**
 - Pyrolysis occurs with the exclusion of oxygen
 - Decomposition of organic substances is carried out at temperatures of 500-550°C
 - Arising heat is used for heating the drum and boiler, **electricity is produced** by a generator
- ✓ **Energetic cycle is created:**
Independence from fossil fuels



BENEFITS OF THERMAL RECOVERY RESOURCES



Why is Aluminium recycling so important?

High demands and expectations of modern packaging

- Consumers attach great importance to product quality and packaging industry expects efficient processing
- Increase use of composite packaging
- Pyrolysis is the only efficient way to recycle and recover these composite packaging

= **Aluminum fulfills these requirements**



Exceptional aluminum recycling makes secondary aluminum a preferred metal for the manufacture of new packaging

- Reduction in energy consumption (95 %) compared to primary production of the same amount and quality of Aluminium

= **Great ecological and economic advantages**

Recycling of Aluminium products
saves over

90 million tonnes of CO₂

and over **100,000 GWh**
of electrical energy

Source: The International Aluminium Institute

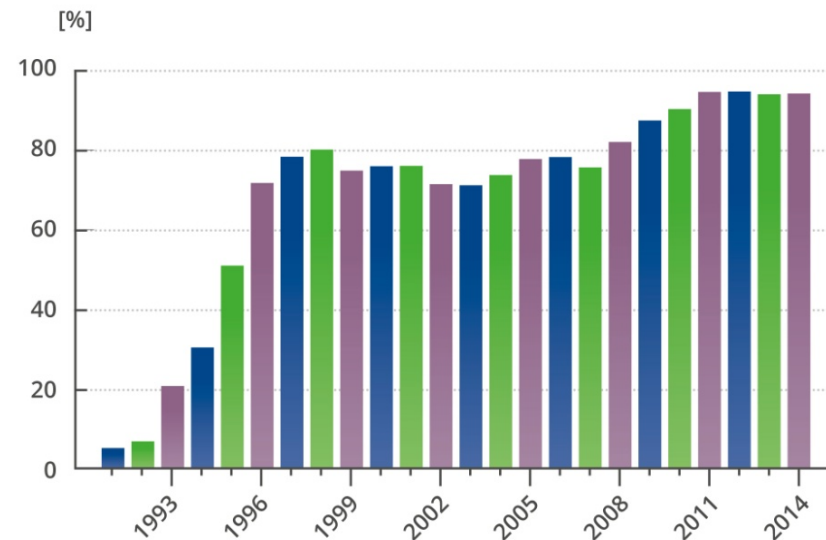


Recycling one ton of Aluminium...

... can save up to:

- **4 tons** of bauxite ore
- **1,8 tons** of chemical products
- and **12.725 kW** of electricity (enough energy to power an average home for over 7 years!)

Recovery rate of Aluminium packaging in Germany (incl. laminates)

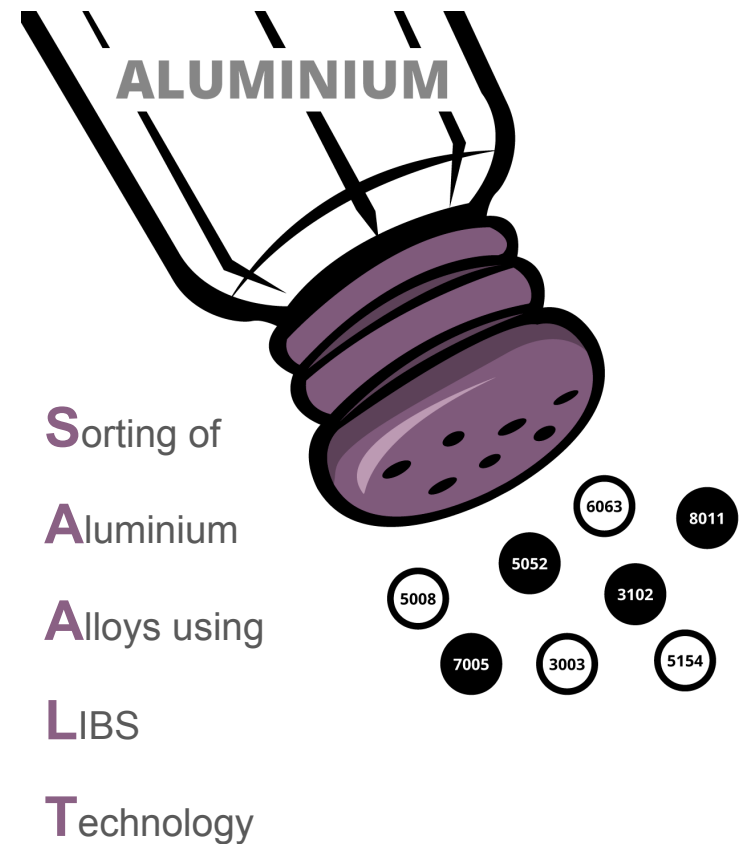


Source: Federal Ministry for the Environment

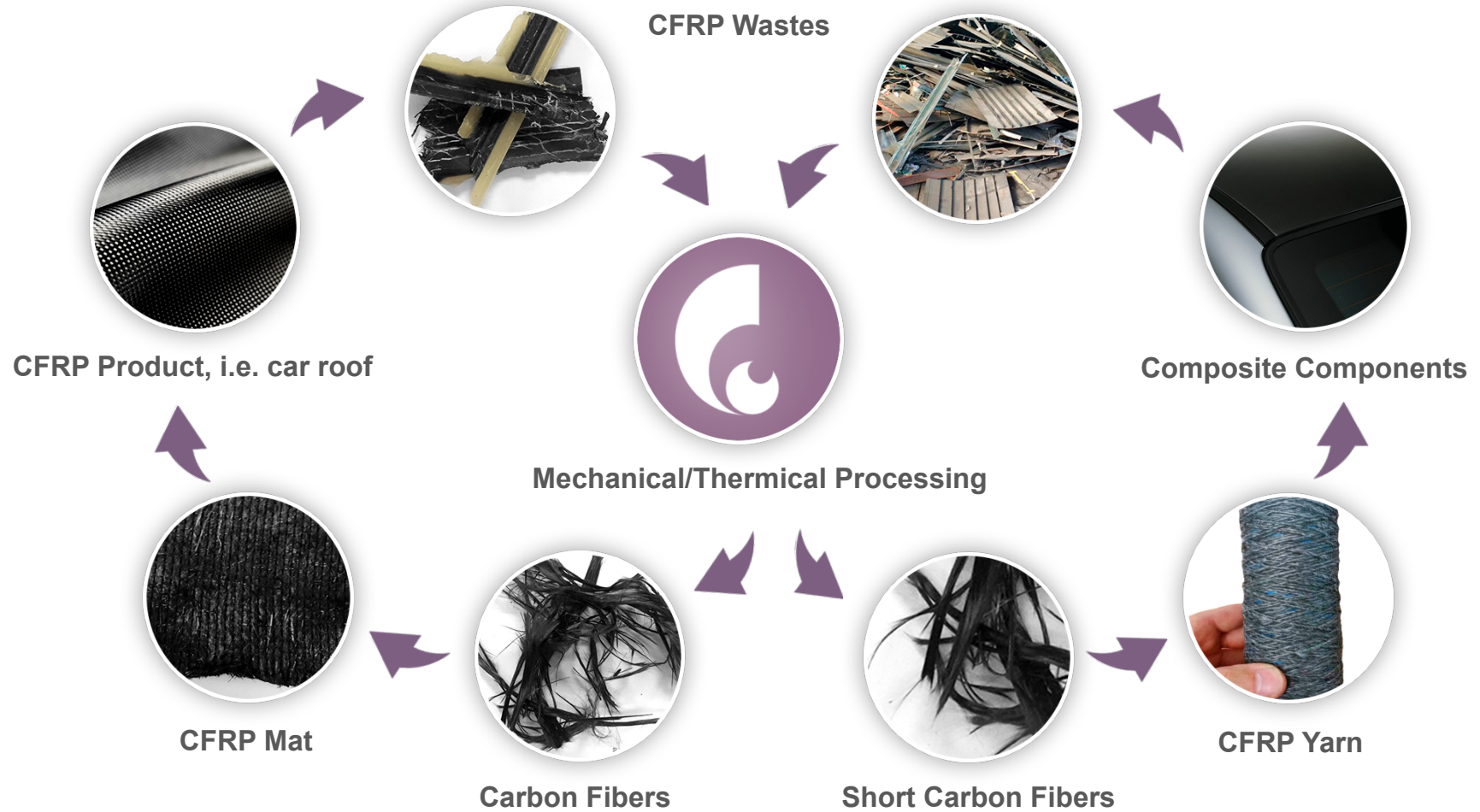


Closing the Loop with the recovered resources

- Through the innovative **S.A.A.L.T. sorting process** an upcycling of the recovered resources is available
 - **Heterogenous Aluminium** pile alloys can **be sorted out** and reused for the same product **without quality reduction**
 - For example, sorting alloy 8011 to produce to new coffee capsules or other new packaging materials
- Sold to processors downstream (smelters/ foundries) and new Aluminium products are produced

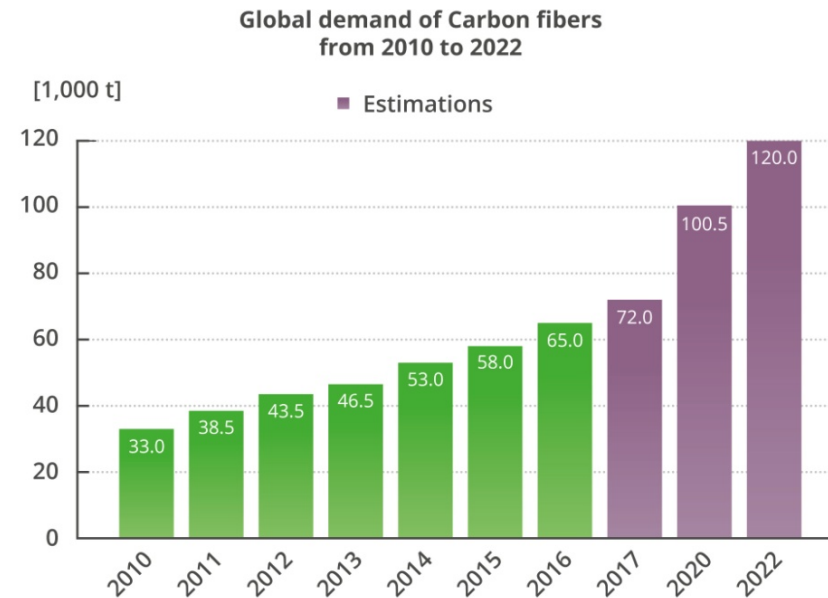


CFRP Recycling



Challenges in CFRP Recycling

- Exposing the fibers without damaging them
- Processing of the fibers so that they can be used again in second generation products
- Development of corresponding marketable products and semi-finished or intermediate products, which are close to their original carbon fiber properties
- **Much higher demand in the future for carbon fibers with a “closed the loop” recycling**



Source: Carbon Composites e.V.



Why is CFRP Recycling so important?

- Production of **CFRP is expensive**:
40–120 €/kg
- Despite the low availability, **between 10% and 30%** of world-wide production find its way **into the waste container**
- **Continuously increasing** fields of application and production rates
- In Europe, landfill and incineration are very problematic for legal and ecological reasons

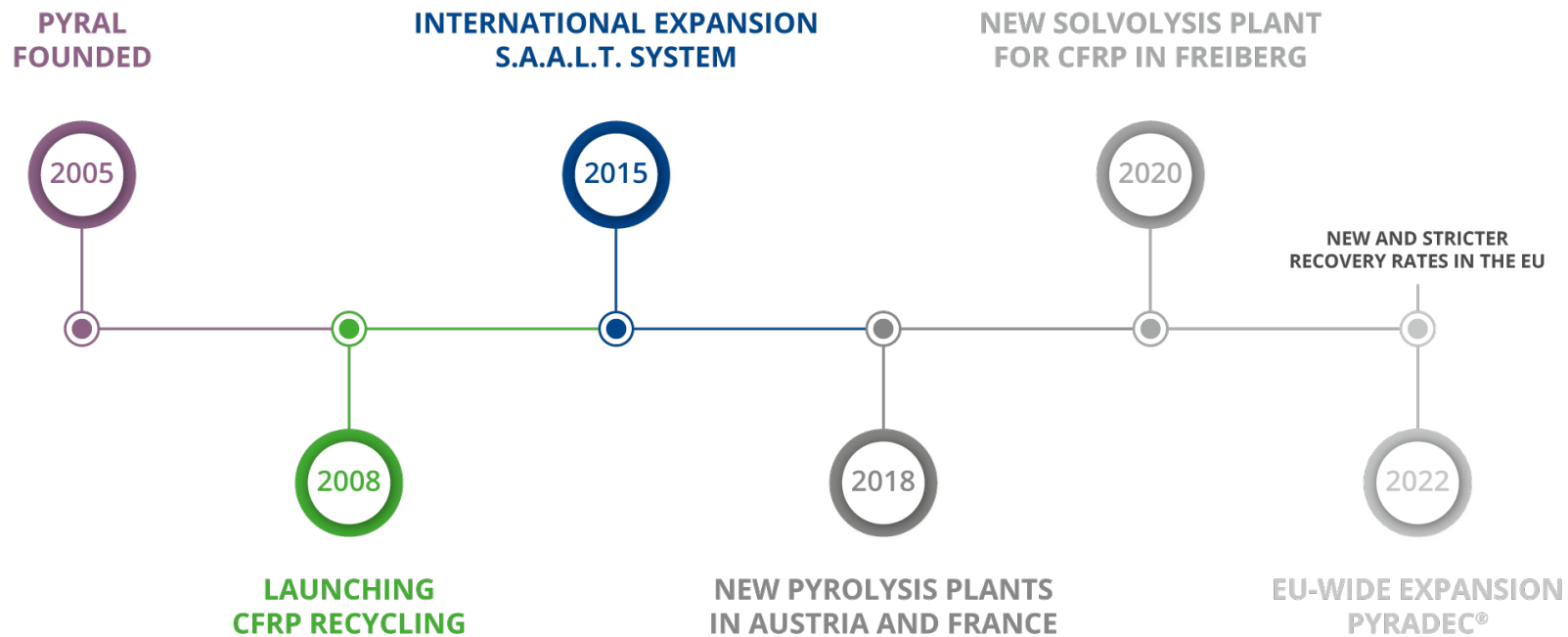


Conclusion: Importance of Pyrolysis

- In the need for more demanding products and packaging composites, technologies must be utilized that can cope with the demands of recycling complex compound materials
- ✓ **The Pyrolysis has shown to be such a technology**
- The experience allows it to separate **organic adhesions from all types of material including Aluminium**
- PYRAL is a member in the CEFLEX consortium
 - CEFLEX is the collaborative project of a European consortium of companies representing the entire value chain of flexible packaging



Conclusion



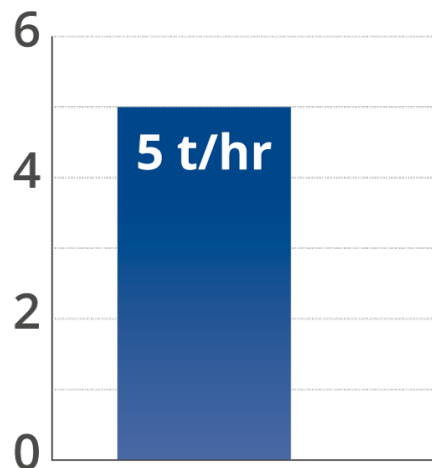
“In the long term, economic sustainability depends on ecological sustainability.”

Dhyani Ywahoo



Overview of the Raw Material – Aluminium

Throughput



Sales Proceeds

1,200 €/t



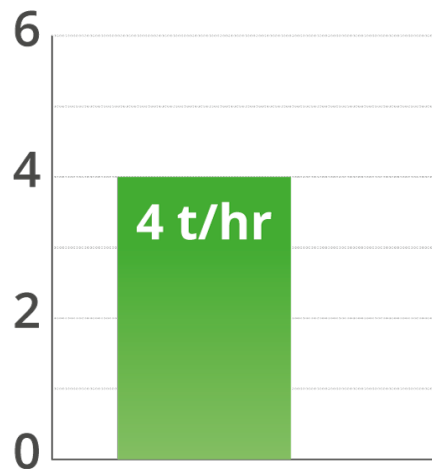
Average Aluminium composition (Input)

30 %



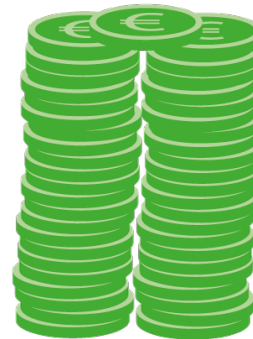
Overview of the Raw Material – Carbon Fiber

Throughput



Sales Proceeds

4,500 €/t



Average Carbon Fiber composition (Input)

45 %



Due to the inert atmosphere of the pyrolysis (no oxygen) the recycled fibres remain intact.



Conclusion

- Waste reduction is important, but equally important is recovering the resources from the already generated waste
- In the future new and stricter recovery rates in the countries of the European Union

“You can tell how developed a society is by how much of its garbage is recycled.”

Dhyani Ywahoo

New recovery rates in Germany

MATERIAL	RATE 2019	RATE 2022
Glas	80 %	90 %
Paper, cardboard	85 %	90 %
Ferrous metals	80 %	90 %
Aluminium	80 %	90 %
Beverage carton packaging	75 %	80 %
Other composites	55 %	70 %
Plastics	90 %	90 %
Material recycling (plastics)	58.5 %	63 %

Source: German Packaging Law (§16)





RECOVERING RESOURCES