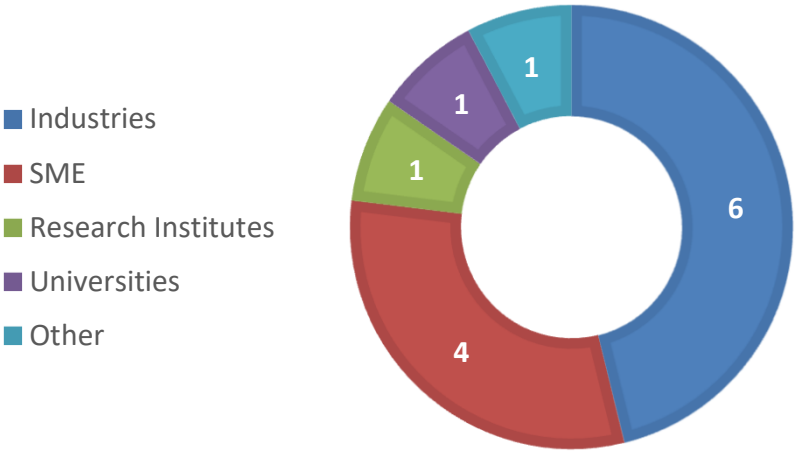

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement N° 820687.

# MMAtwo project at a glance

- Second generation Methyl MethAcrylate
- Innovation Action – Grant Agreement N°820687
- 13 partners from 6 different countries
- 8.9 M€ budget (6.6 M€ grant)
- From 01/10/2018 to 30/09/2022
- Key words: Recycling, Depolymerization, PMMA, Thermal, Monomer, Polymer, MMA, Plastic waste, Plastics technologies, Sustainable design, waste management, materials engineering, Circular economy, Sustainable design




# MMAtwo major objectives & methodology

- PolyMethylMethAcrylate, 'PMMA' used in optical, signage, displays, decorative, vehicles, construction, electronic screens etc.
- Production in Europe around 300.000 tons annually; recycling capacity in Europe around 8 000 tons annually.
- Objective: Construction of a new value chain for post-production and end-of-life PMMA waste recycling in collaboration with producers, waste collectors, processors, end-users and the academic community through depolymerization and recovery of MMA, using a lead free environmentally friendly and accessible technology (continuous process).
- Results to be exploited into EU PMMA recycling business(es)

# Circular Economy

Raw Material

Produce

Use

Collect

Dispose

STOP

Landfill

Production Scraps

Refurbish / Remanufacture

Share/ Reuse

COVOITURAGE

Vehicles

Recycle

Energy Recovery

CO2 utilization

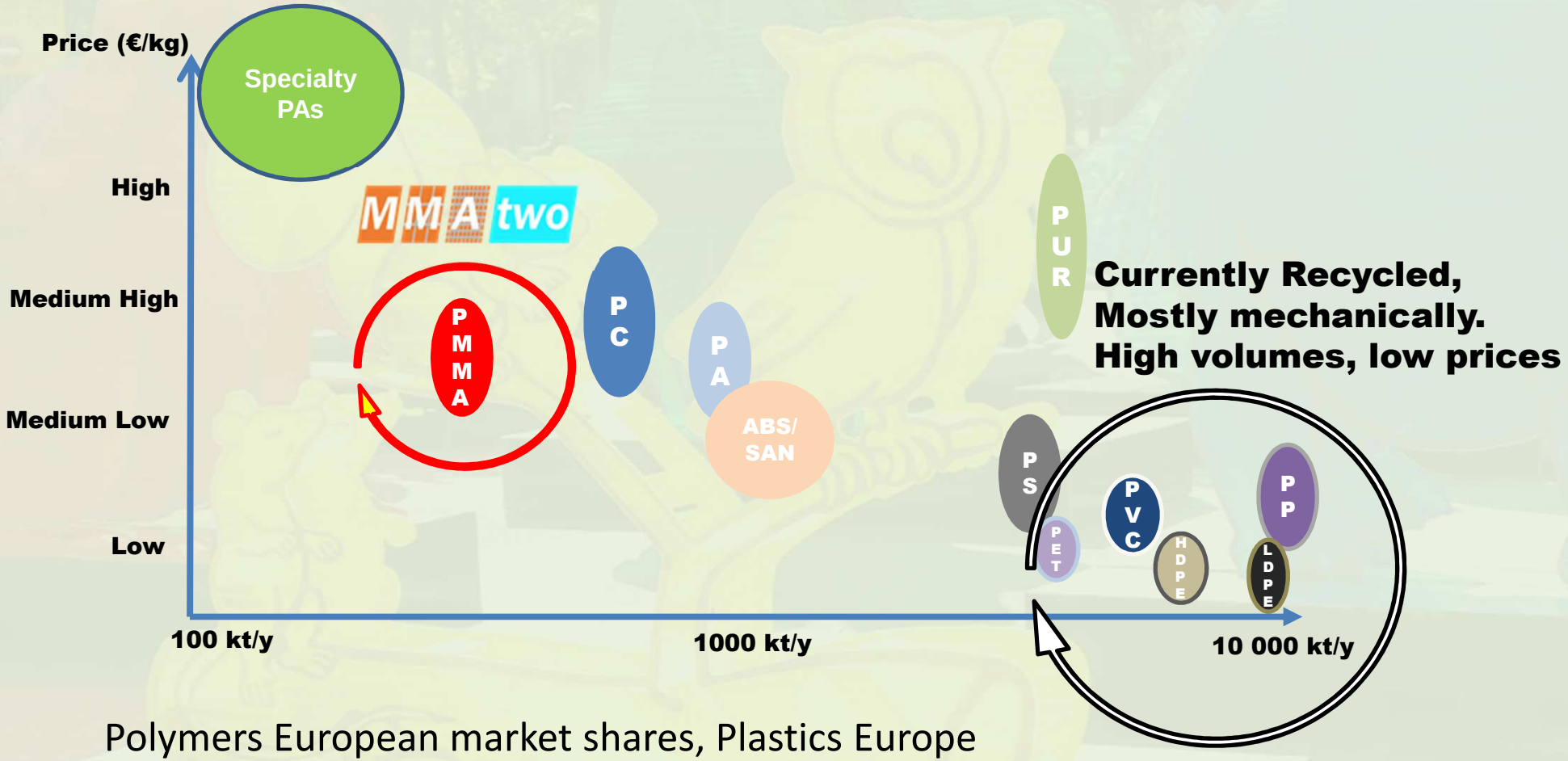
Displays

Signage

Construction

LCD –flat screens

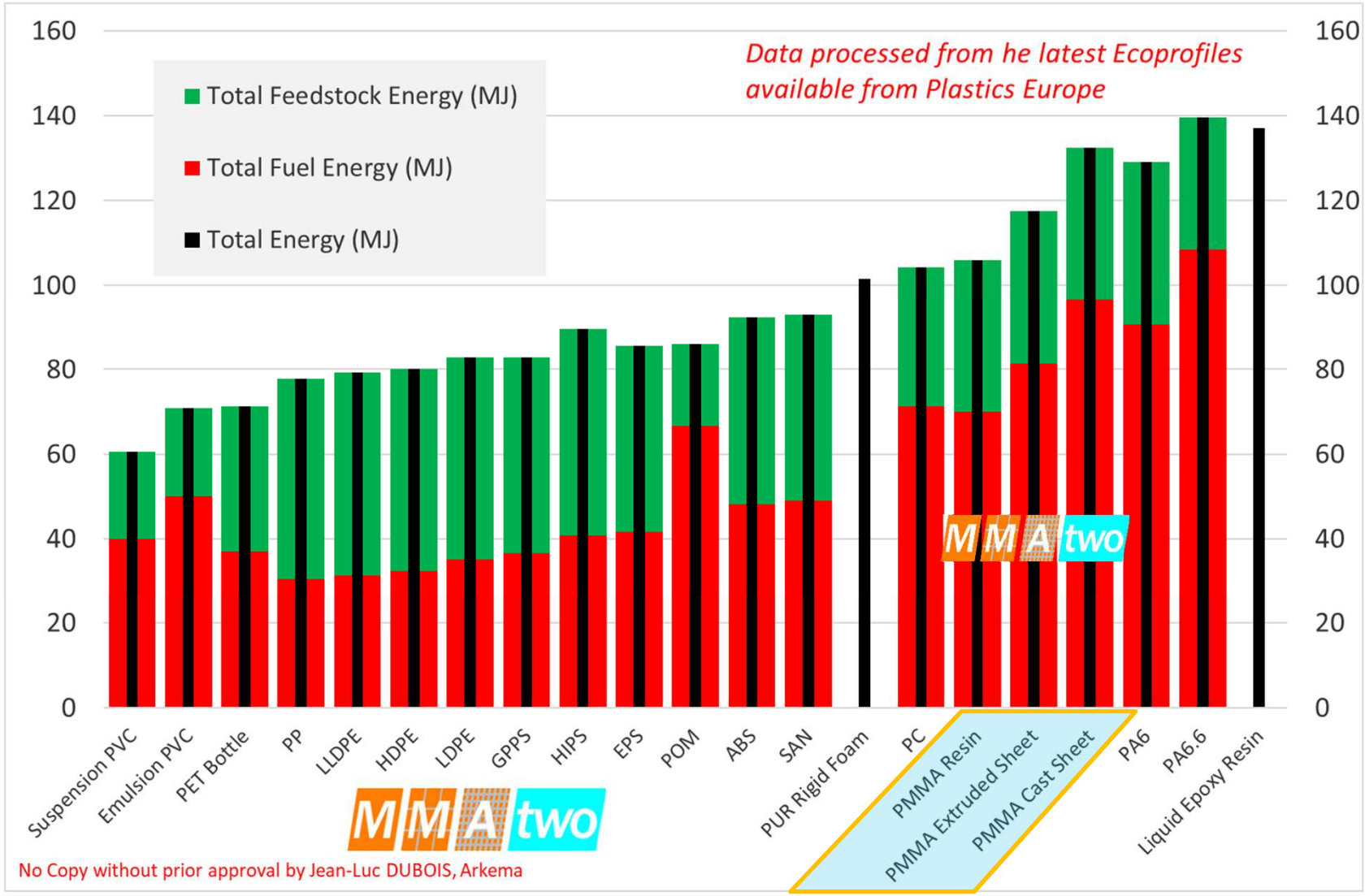
# PMMA: high value, but low volume




Polymers European market shares, Plastics Europe
Plastics converter demand by resin type (2016)

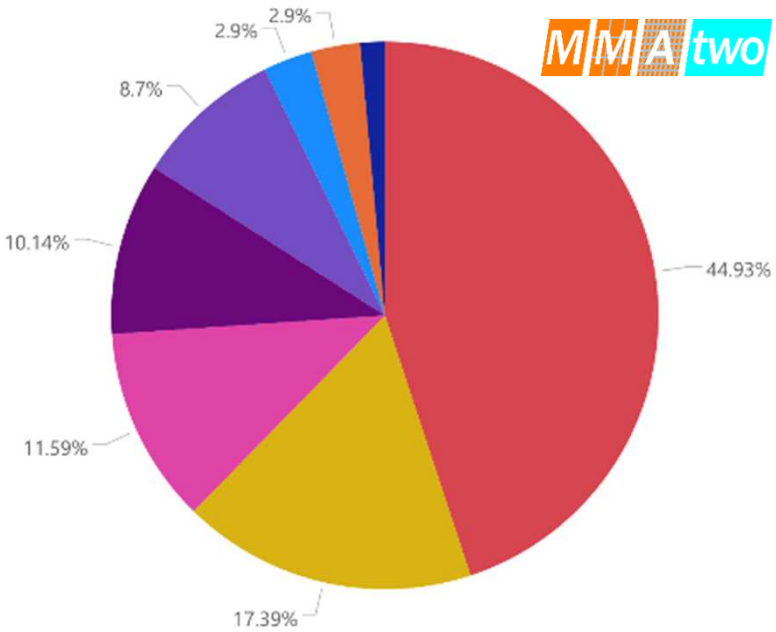
Source: JL DUBOIS –November 20th 2018

# Energy Consumption in Polymers production: High demand for technical polymers



# Waste collection and Pretreatment

In collaboration with **Ecologic** and **Comet**, **Heathland** collected end-of-life PMMA WEEE waste and vehicle waste. PMMA with PVC waste was collected by **Heathland** from **Arkema** and **Delta Glass** and purified using specialized pretreatment technology into a raw material for the first depolymerization runs.




Waste description

- PMMA sheet scrap
- PMMA sheet regrind
- PMMA LCD scrap
- PMMA injection regrind
- PMMA saw dust
- PMMA glassfibre regrind
- PMMA greenhouse scrap
- PMMA glassfibre scrap

HEATHLAND

EcoLogic

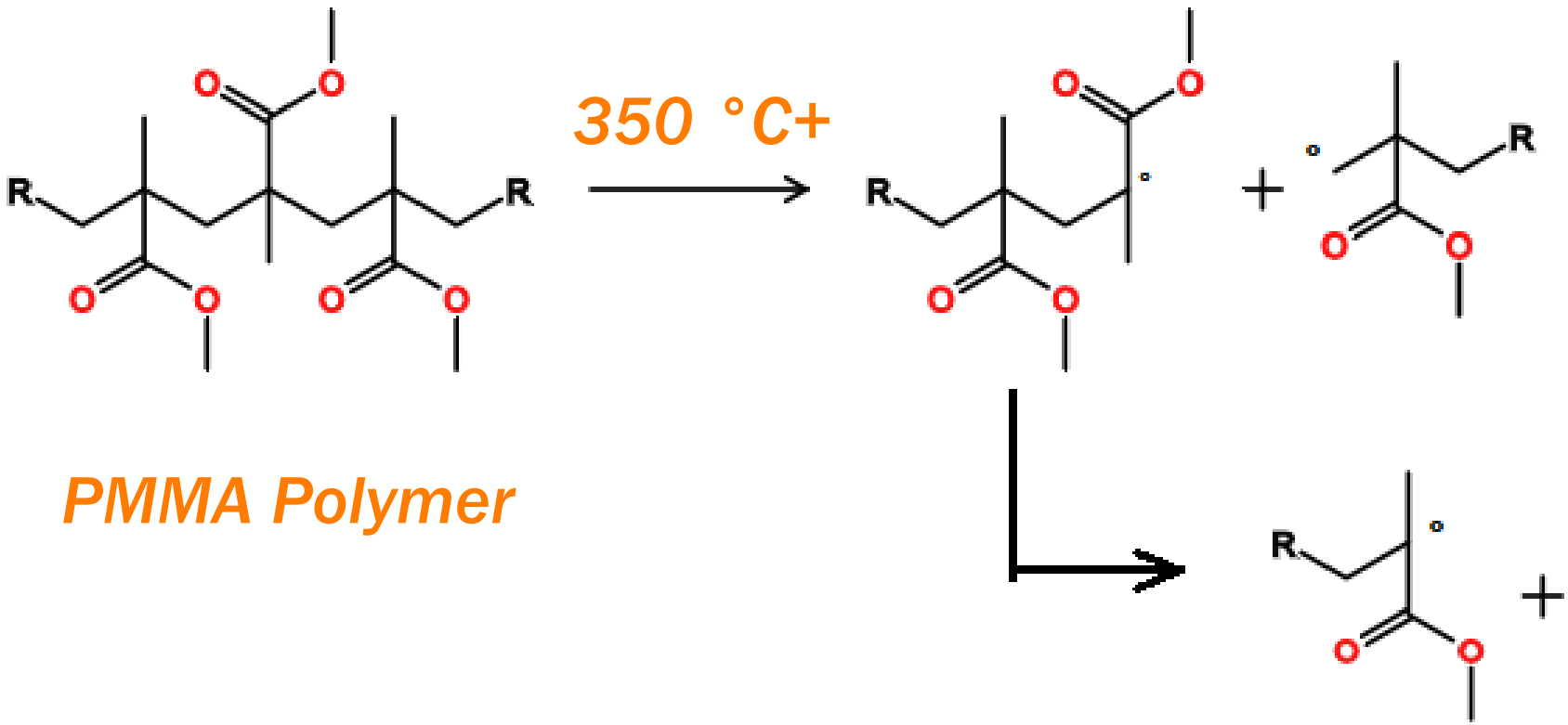
La 2e vie des équipements électriques

comet traitements

DELTA GLASS

ARKEMA

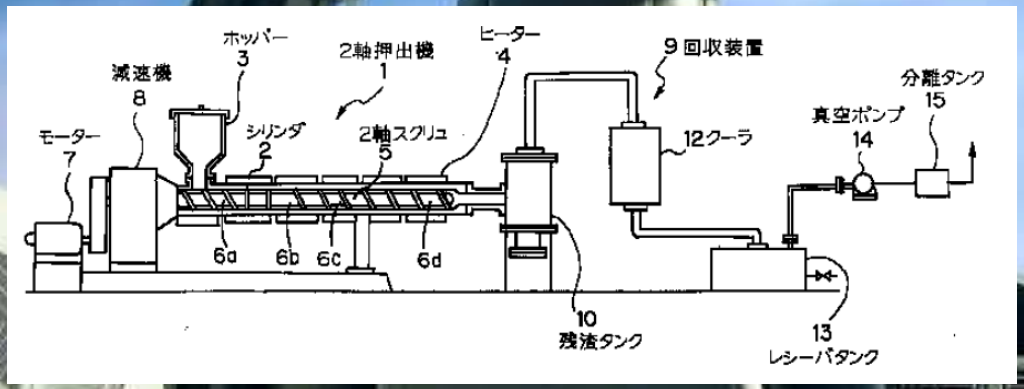
# PMMA Thermal depolymerization process Radical Unzipping Mechanism



# MMAtwo twin-screw in JSWEurope

**SELECTED TECHNOLOGY**

In a patent (priority 1997) JP3410343, **Japan Steel Works** describes an extruder type equipment, in which the depolymerized products is discharged at the end of the screw and solid residues are collected separately.

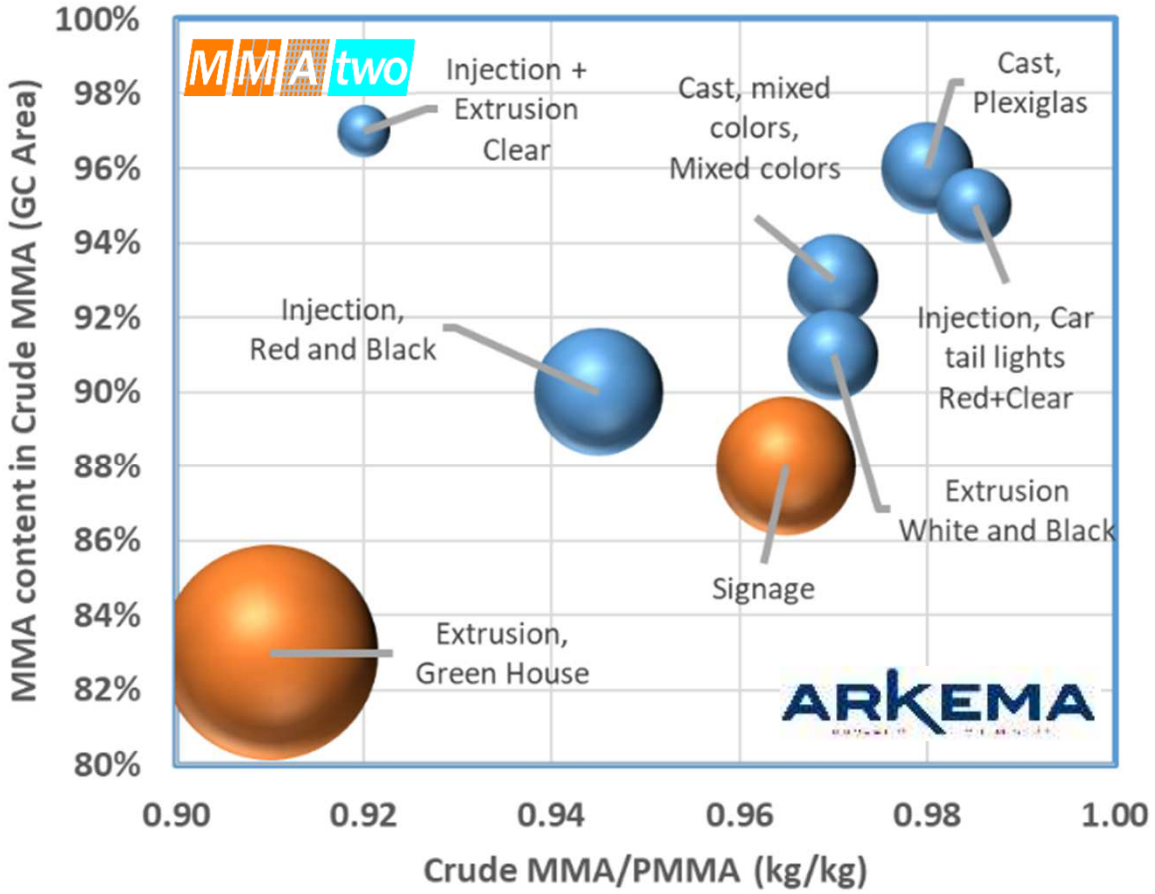




*See the video describing the pilot on www.MMAtwo.eu*

# Depolymerization

Several PMMA waste products (post-industrial and post-consumer) have been depolymerized by **Arkema** at bench scale. High mass yields with high monomer content can be achieved with most of the grades.

**JSW Europe** modified the existing twin screw extruder to operate at high temperature for the depolymerization trials. Heating-up test and gas leakage inspection of new barrel assembly were completed and the extruder is ready for being connected with a condenser for recovering the monomer.




Orange: Post-Consumer, Blue: Post Industrial

# MMAtwo first depolymerization pilot tests completed (June 2020)


**See the video taken during the pilot tests on www.MMAtwo.eu**

**Recycled Methyl Methacrylate through PMMA depolymerization**

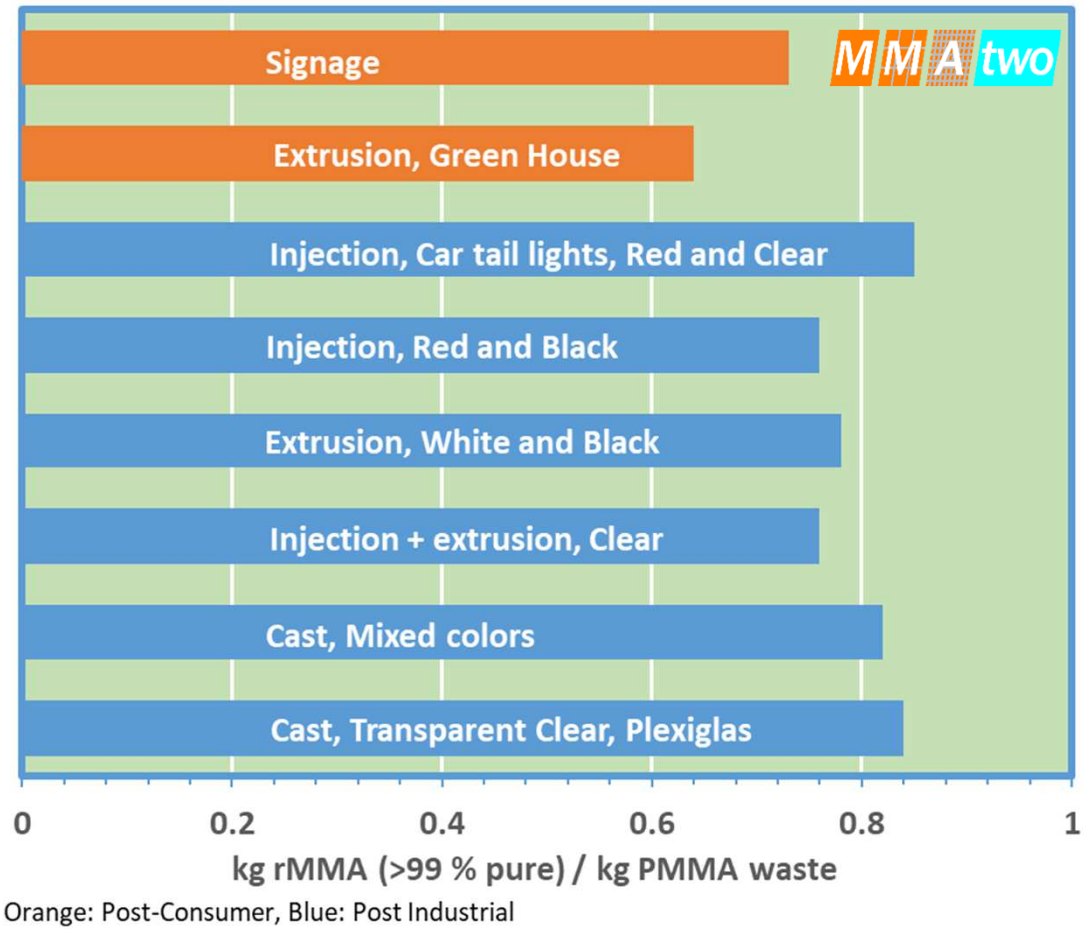
# Mass Balance: Plastic to Monomer/Polymer yields (data from MMAtwo)

© ARKEMA Speichim processing Séché global solutions

The crude MMA samples obtained at bench scale were further purified by **Speichim** to above 99 % purity grade.

The mass yield of high purity monomer from PMMA waste ranges from 64 to 85 wt %. All PMMA wastes were successfully converted to high quality (>99 %) monomer.

*Source: MMAtwo Newsletter N° 2*
*Available on MMAtwo website*

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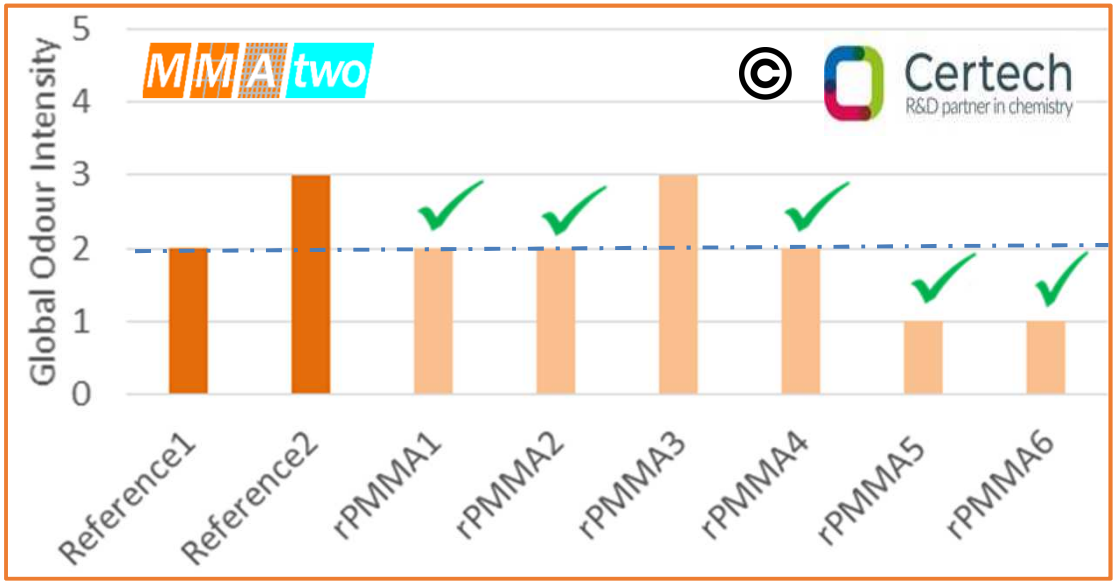



# r-MMA end uses

Global odour intensity determination by human panel was performed at Certech:

5 out of 6 rPMMA polymerised using rMMA from various sources (industrial scrap and post-consumer) have a global odour intensity lower or equal to that of Reference1 which is PMMA from virgin MMA. Reference2 is a copolymer doped with odorous impurities typical of PMMA depolymerisation.

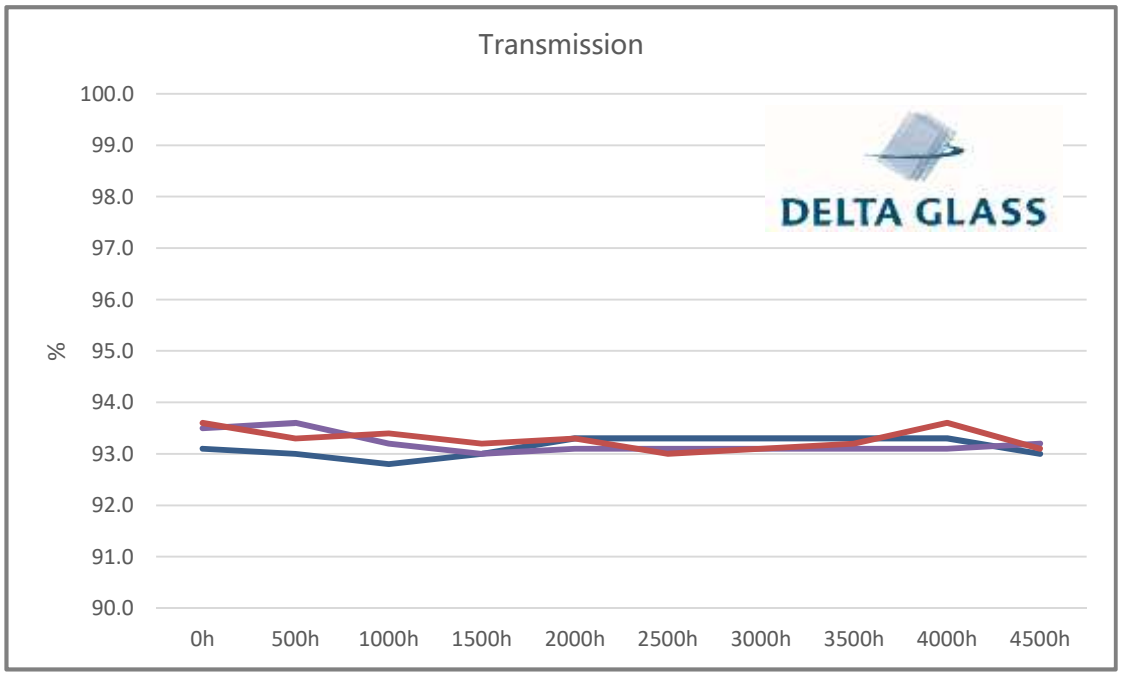
Delta Plados progressed with works on 3 different products from the recycling process, providing a base for consecutive lab trials and application in end-products.

# Polymer to Polymer validation

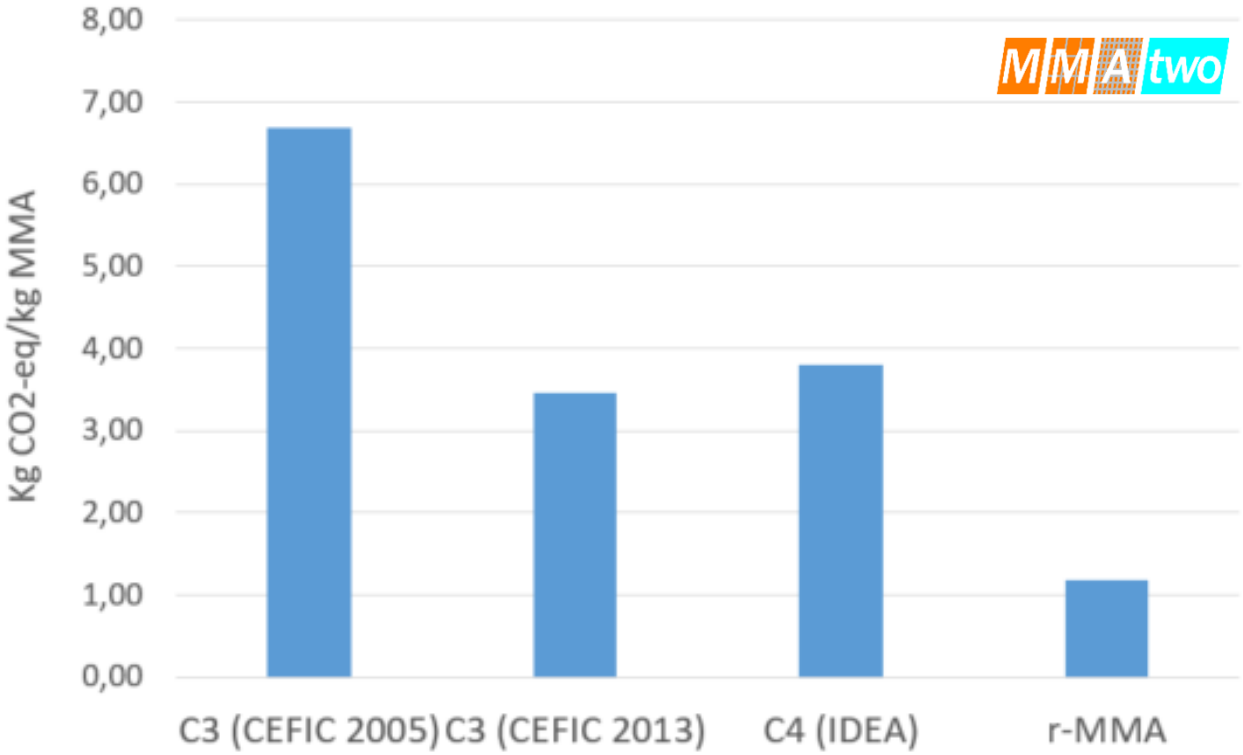
# Cast sheet from recycled MMA

**Delta Glass** performed an accelerated weathering test on PMMA sheets made from rMMAs, optical transmission (%) at 4500 h, aging being identical to the reference virgin material.

Transparent PMMA cast sheet from rMMA

# First Environmental life cycle assessment and life cycle costing




## Preliminary results

### *Benchmark routes analyzed*

- C3 Acetone cyanohydrin (EU): CEFIC data. 2005, 2013
- C4 Isobutene (JP) : IDEA db
- rMMA lead-bath (EU): 2 reports

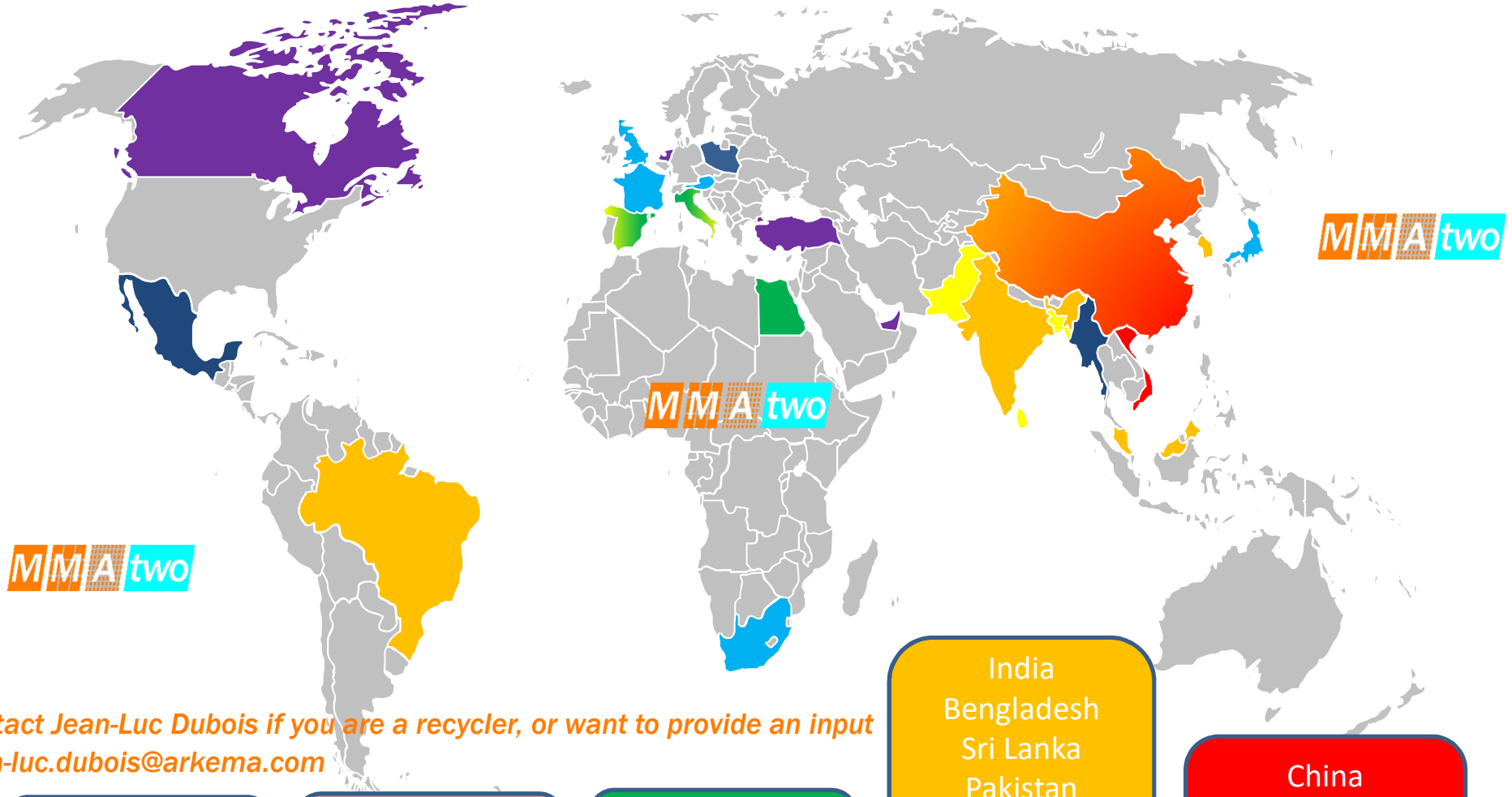
### *Carbon footprint*

Compared to virgin production:

- -69% C4 route
- -66% C3 route (CEFIC 2013)

# Recycled Methyl Methacrylate World Map

Closed facility | Molten metal Technology | Dry distillation Technology | Rotating Drum Technology | Unknown (yet) Technology | Possible new plant



*Contact Jean-Luc Dubois if you are a recycler, or want to provide an input*
*Jean-luc.dubois@arkema.com*

| Americas | Europe | Middle East | India<br>Bengladesh<br>Sri Lanka<br>Pakistan<br>Malaysia | China<br>Vietnam |
|---|---|---|---|---|
| 2 000 t+ | 7-10 000 t | 5-10 000 t | 20 -30 000 t+ | 100 000 t |
| 5-10 companies | 3-5 companies | 2-3 companies | >30, leaders | Many, 2 leaders |



*Recycled MMA World Map*
*Prepared by Jean-Luc DUBOIS (Arkema)*
*with Simon Van der Heijden (Heathland)*

# To learn more about MMAtwo…

Website address https://www.mmatwo.eu

Register at the contact page

# Advisory Board contacts

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