



## Chemical recycling, the key to a more sustainable chemical and plastics industry

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**Plastix**



# The global sustainability challenges



**ZERO: CO<sub>2</sub> by 2050; 55 by 2030 (EU)**



Reduce CO<sub>2</sub> emissions

**ZERO: WASTE**



Responsible and sustainable handling of waste

**ZERO: FOSSIL CARBON EXTRACTION**



(Plastic) Circularity

In line with most international initiatives:

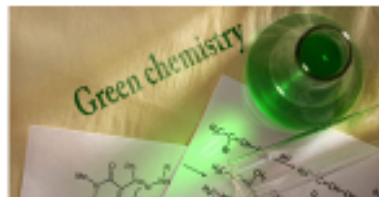


# Circular Biobased Delta Focus towards 2030

## Biogenic routes



## Green Chemistry



## Programs

Biofeedstock

Bioprocessing

Biochemicals & Materials

## Circular Solutions



## Chemical recycling



## Programs

Solvolyis

Depolymerisation

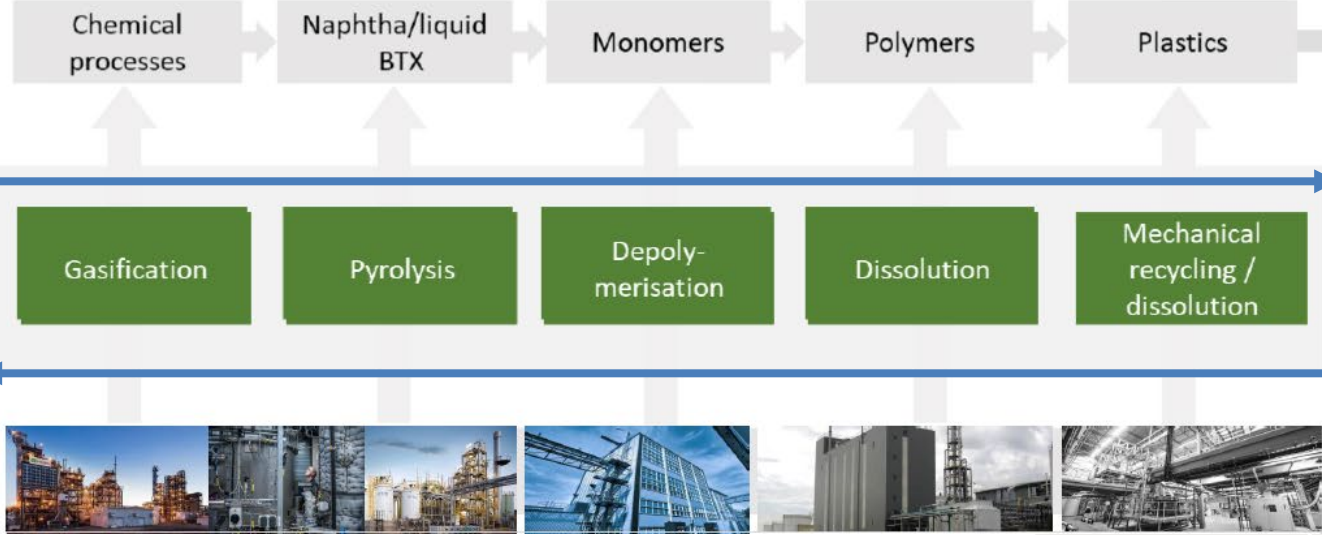
Pyrolysis

Gasification



# Chemical Recycling in the Netherlands

Energy Need  
Technology  
Feedstock quality



Enerkem, Gidara

Numerous  
Next Pages



Cumapol - CuRe  
Synova-Trinseo  
Koch- Ioniqa



Polystyrene Loop



QC Polymers  
Retourmatras



Collection

Key points:

- More feedstock options
- Waste problem down
- Energy intensity (CO2)
- Quality/purity feedstock
- Pyrolysis hot or hype ?
- Collaborations SME's-Majors
- Upscaling/operational excellence



# SABIC Circular Polymers production in NL by end 2022



Production by SPEAR= SABIC Plastic Energy Advanced Recycling BV  
Capacity 20,000 t/a of mixed plastic waste input

SABIC pyrolysis oil upgrading with H<sub>2</sub> for use in the cracker



- Demonstrated in Spain
- Continuous process
- ISCC certified



# Upscaling Chemical Recycling in the Netherlands



**Shell en BlueAlp plan to build two pyrolysis plants in The Netherlands**

Scale: 30 KT/a each by 2023

**Ravago en Neste plannen recyclagefabriek in Vlissingen**



Scale: 30 KT/a each by 2023

Scale: 55kt/a capacity by t.b.d



**Dow and Fuenix Ecogy Announce second plant Weert (NL)**

Scale: 20kt/a capacity by t.b.d

**FEEDSTOCK IS MIXED PLASTIC WASTE**

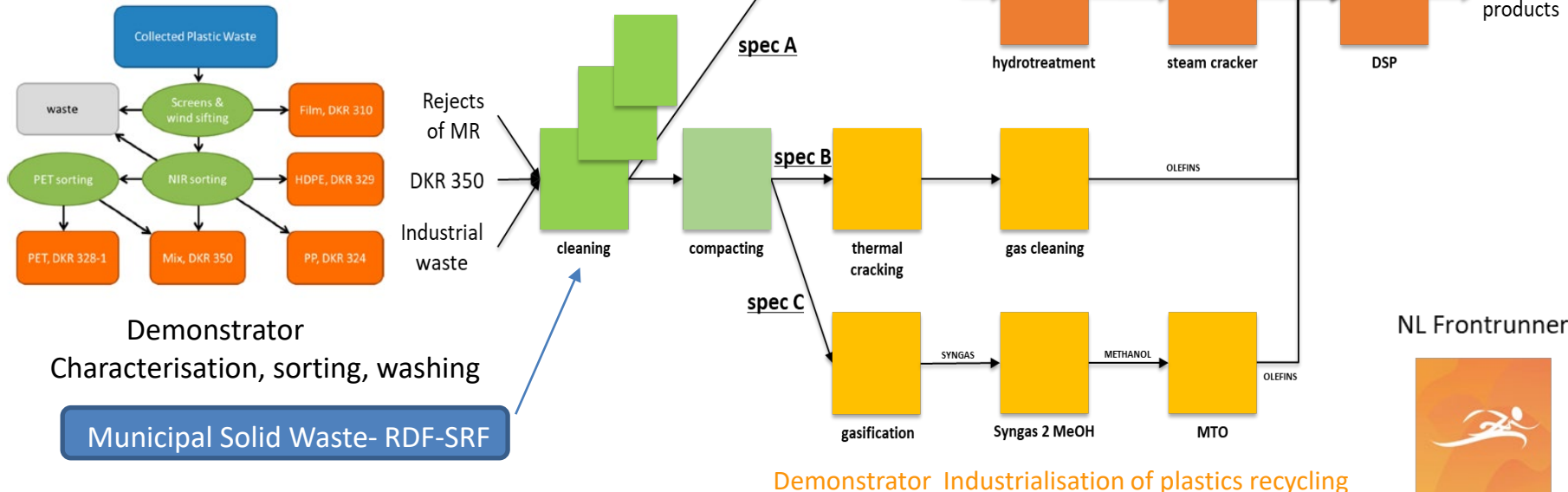
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# Example 1: Funding for scaling-up thermochemical recycling (DGF)



## Classification Thermal Conversion

Ref	Route	Air ratio	Temp	Main Product
A	Pyrolysis	$\lambda=0$	400–500	Pyrolysis Oil
B	Cracking	$\lambda=0$	750	Product Gas
C	Gasification	$\lambda=0,3$	>1000	Syngas



# Next to Biomass... Municipal Solid Waste and RDF/SRF

*new feedstock for chemicals... with challenges (N, O, S, Cl, H<sub>2</sub>O)*



- Lignocellulosics to bio-ethanol, glycols, BTX, funct. aromatics, tall oil
- Carbohydrates to bioethanol, Lactic Acid, Citric, BDO, furanics
- Lignine to (mixed) bio-aromatics and bitumen replacement
- Biomass waste has positive value/price



- **Biomass-rich RDF** fraction from MSW has negative value/price
- Typical 18% plastic, 30% water, 10% ash, 42% biomass
- Too heterogenous for most pyrolysis processes
- Mild gasification/cracking possible to RNG (TRL 7)
- Gasification to syngas is state-of-the-art (TRL 9)



- **Plastic-rich RDF** fraction from MSW has negative value/price
- Typical 59% plastics, 1% water, 11% ash, 29 % biomass
- Too heterogenous for most pyrolysis processes
- Mild gasification/cracking possible to High Value Chemicals,
- Gas cleaning is essential step

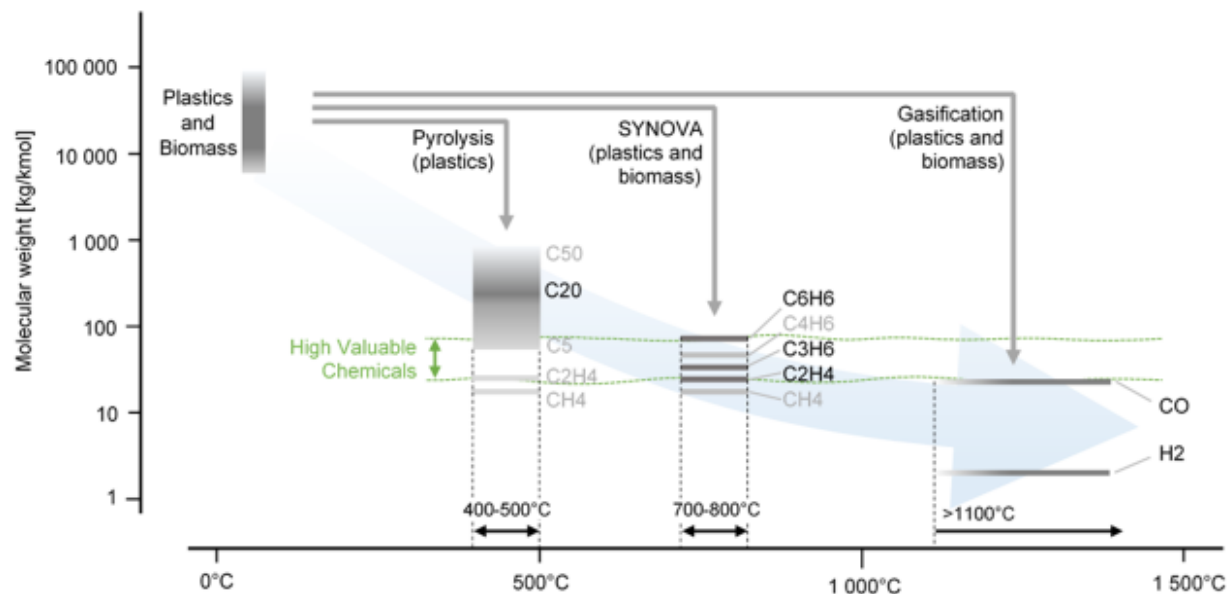
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## Example 2: Thermal depolymerisation to High Value Chemicals

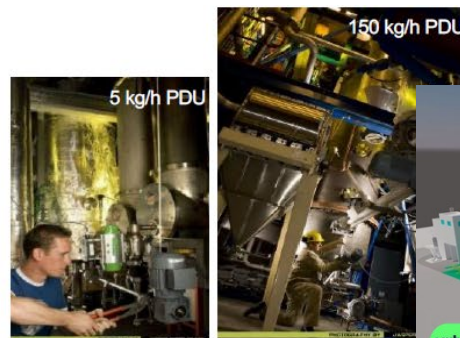
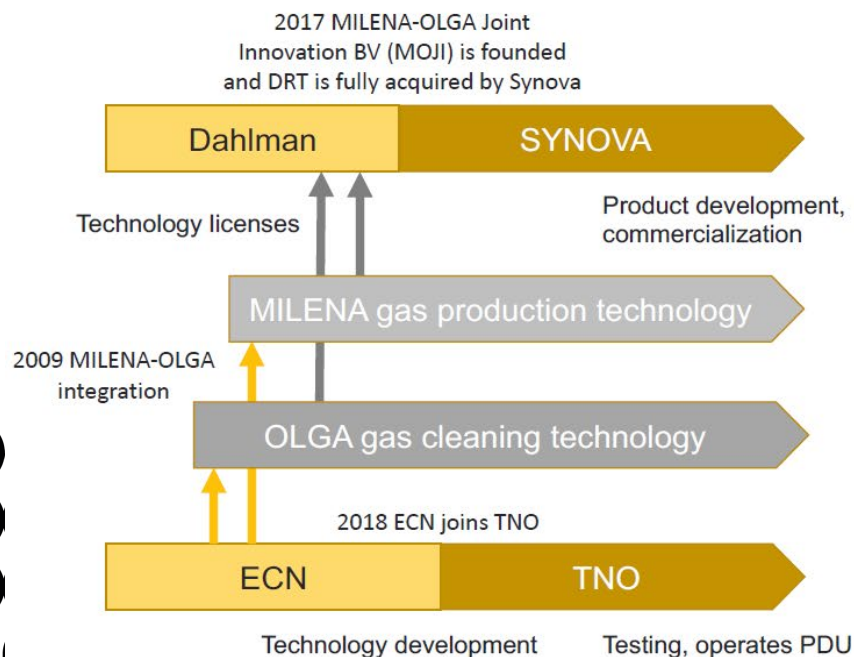
### Synova process between pyrolysis & gasification

SYNOVA's SOLUTION  
MEDIUM TEMPERATURE = DIRECT CHEMICALS

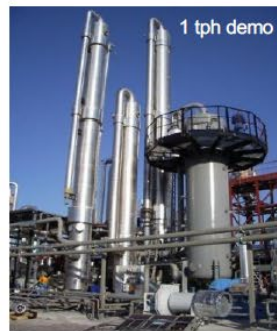


# Route 2.0 to Chemical Recycling via Thermal Depolymerisation

SYNOVA



15.000 tpa project



# Environmental Impact of various Chemical Recycling routes (1)

Reduction Kg CO<sub>2</sub>-eq/kg product

Values on the basis of product comparison vs fossil route (CBBD Roadmap CE Delft)



Depolymerisation of **condensation** & **addition** polymers  
**polyesters, nylons, PC** & **Polyolefins, PS, PMMA** (2.0-2.5)

Pyrolysis of mixed plastic waste (1.0-1.5)

Gasification of waste2syngas (0.5-0.75)

# Environmental impact of Chemical Recycling routes (2)

## Correlation with CO<sub>2</sub> reduction

### Monitoring Chemical Recycling

Methodology checked with cases with industry.



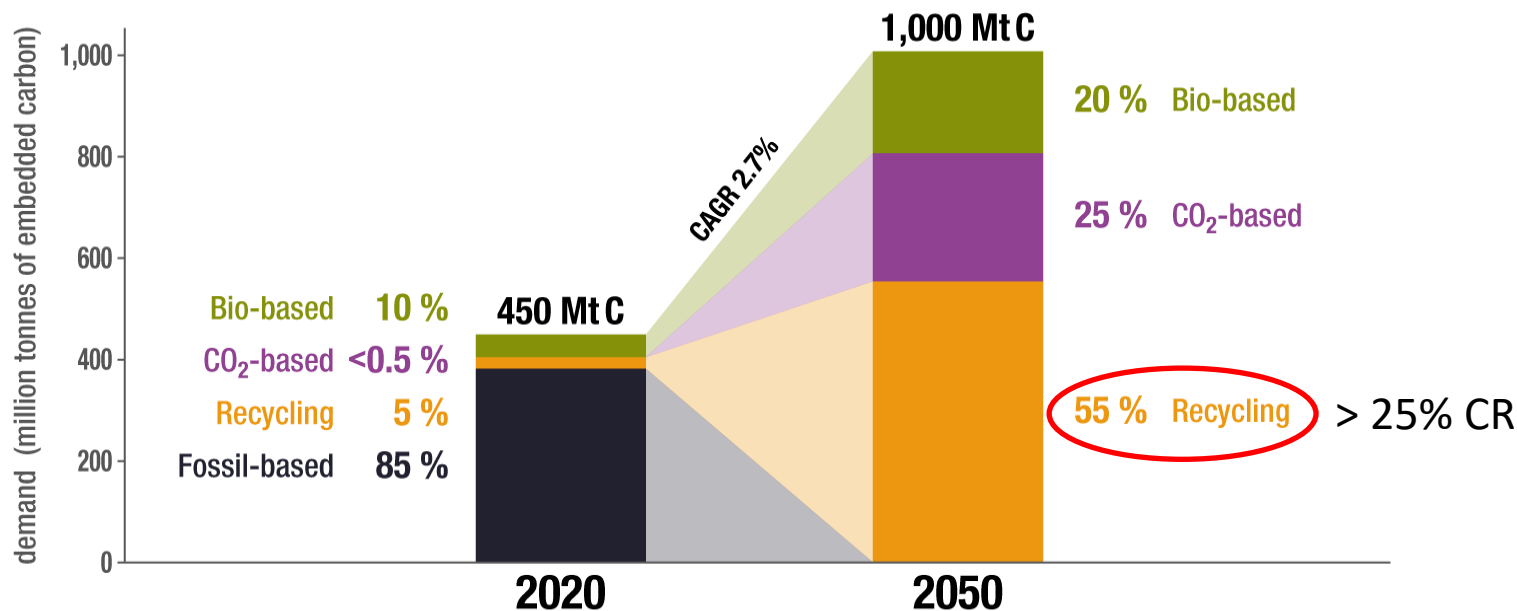
CE Delft  
Committed to the Environment

Technology	Carbon footprint reduction compared to incineration in MSWI kg CO <sub>2</sub> eq./kg plastic in waste [A]	Plastic-to- plastic yields (Table 3) [B]	[B] / [A] * 100
Mechanical recycling mono-materials	2.5 to 3.5	89-100%	25-36
Mechanical recycling mixed plastic	Around 2	60%	30
Solvent-based purification/ depolymerisation	Around 3	97-100%	32-33
Pyrolysis	Around 1.5	49%	33
Gasification	1.0 to 1.5	34%	23-34



# Global Carbon Demand for Chemicals and Derived Materials

in 2020 and Scenario for 2050 (in million tonnes of embedded carbon)



CR is key to a more sustainable chemical and plastics industry

## Conclusions – Main take aways



- Chemical Recycling is key to a more sustainable chemical and plastics industry
- Pyrolysis of plastic waste is where the current focus of the industry is
- The Netherlands plays a leadership role with many demo and flagship projects
- The partnership between innovative SME's and corporates is critical
- Current feedstock for pyrolysis competes too much with mechanical recycling
- Medium term we need technologies that are more agnostic to feedstock quality:
- Synova Renewable Technologies, Olefy technology (VTT), and gasification to syngas



Thank you for your attention



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