Chemical Recycling and Circular Economy

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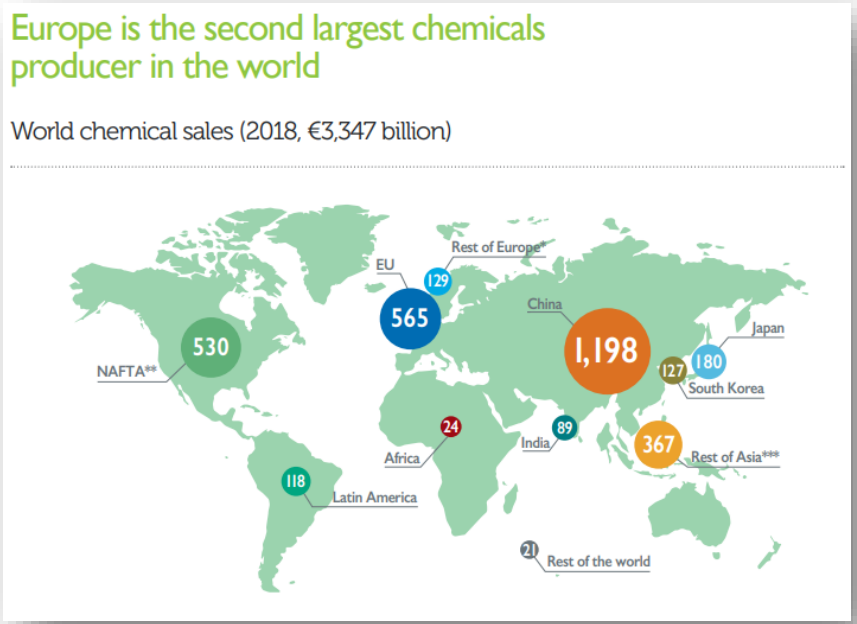
European Refining Technology Conference
17TH + 18TH November 2020

Cefic is the voice of the chemical industry in Europe

- Based in Brussels since 1972, Cefic has grown to become one of the **largest trade organisations** in Europe and in the world
- Representing large, medium and small chemical companies in Europe – **1.2 million jobs** – **16.9%** of world chemicals production
- One of the **most active networks** of the business community: companies + national federations + industry (sector) associations
- We **interact every day** on behalf of our members with international and EU institutions, non-governmental organisations, the international media and other stakeholders



Source: Cefic; *2020 Facts & Figures*

Voice of the Petrochemical Industry in Europe

- An industry sector of Cefic, the European Chemical Industry Council representing manufacturers and National Chemical federations
- >70 companies: European producers of base chemicals and derivatives
- Base chemicals: 20 companies operating around 50 steam crackers in EU28
- 40 units integrated with refineries

Our 8 key priorities

- Electrification
- ETS & CO2 Neutrality
- Technology & Innovation, CCS, CCU, Pyrolysis
- Hydrogen
- Recycling & Mass Balancing
- Chemicals Strategy for Sustainability
- Level Playing field, Cost Effective Transition
- Energy Process Efficiency

The Circular Economy 2.0

The chemical industry:
a key enabler of the circular economy

*"Transitioning towards a circular economy can contribute to addressing our global **resource challenge, reduce greenhouse gas emissions** through better **use** and **reuse** of the materials that already exist in the economy, reduce environmental littering, create new meaningful **jobs**, and spur **economic growth**. Going more circular means contributing to meeting the Paris Agreement and the broader UN 2030 Sustainability Development Goals"*

Source: Cefic; *Position Paper Circular Economy*

MOLECULE MANAGERS

A journey into the **Future of Europe** with the **European Chemical Industry**

Welcome to 2050!

Circularity: The European Economy has gone circular, recycling all sorts of **molecules** into new raw materials

EU Plastics Strategy January 2018 + Green Deal December 2019

Under the **Plastics Strategy**, the European Union will:

- Make recycling profitable for business + Drive investment and innovation
- Curb plastic waste + Stop littering at sea
- Ensure by 2025: **Ten million tonnes of recycled plastics** in products in the market

Cefic Position:

- High focus on mechanical recycling and alternative feedstock
- Chemical recycling is an essential **complementing** step to "valorise" post-use plastics
- Mass Balancing and Life Cycle Assessment are key

EU Circular Economy Action Plan:

- Design for re-use and recyclability of packaging
- Mandatory requirements for recycled content and waste reduction measures

Cefic Position:

- Support the overall ambitions of the European Green Deal

Creating a Circular Economy for Plastics

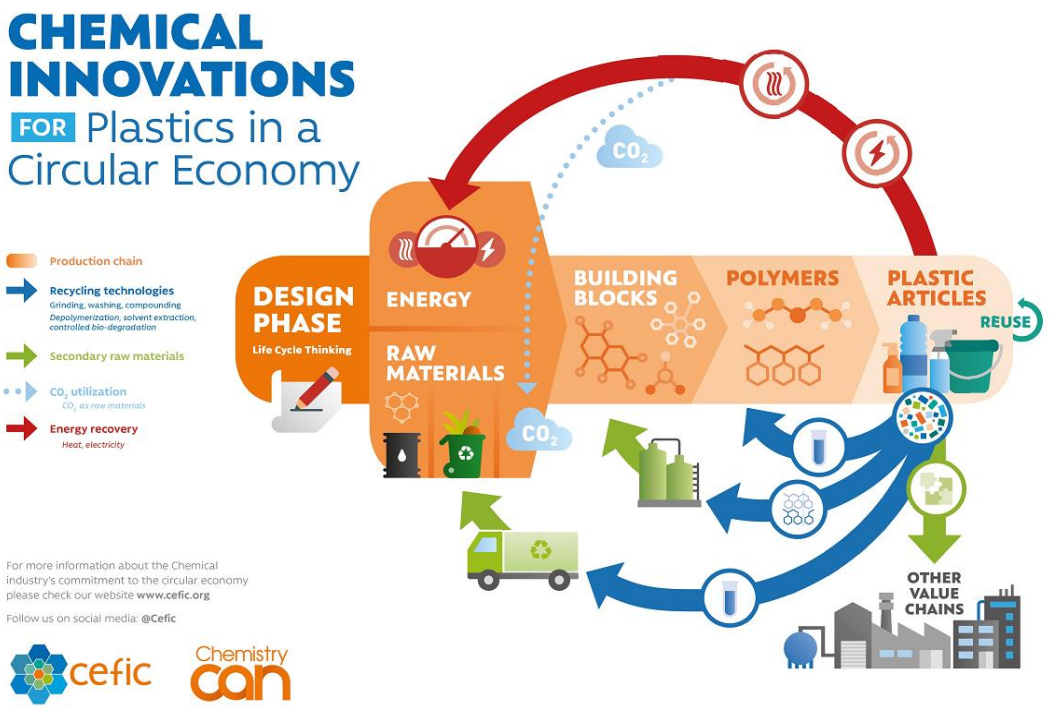
*"Every year, Europeans generate 25 million tonnes of plastic waste, but less than **30%** is collected for recycling"* states the 2018 European Plastics Strategy.

15% of the plastic waste collected today finds its way back to the market

- Mechanical Recycling + Sorting

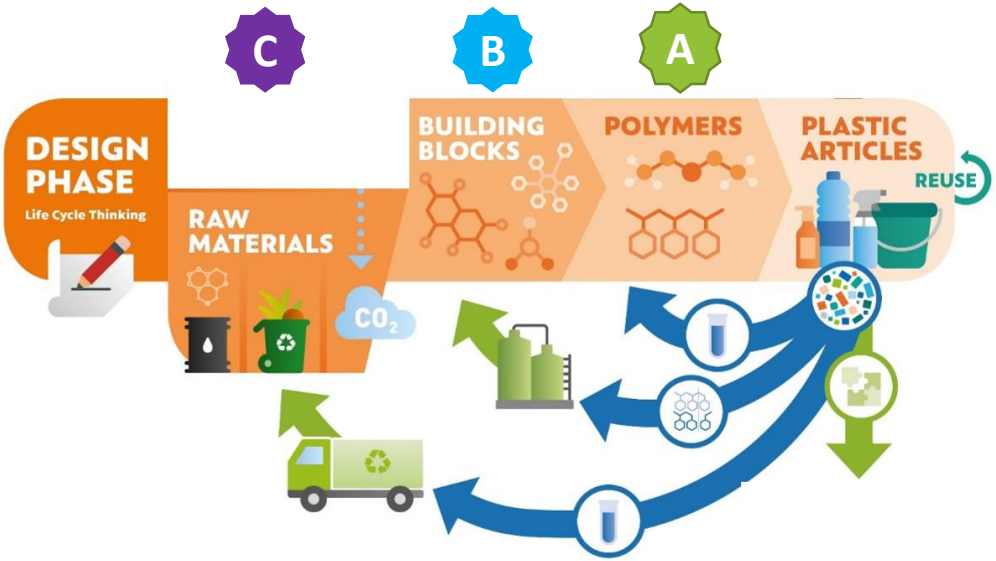
85% is currently incinerated or landfilled

- Opportunity for Chemical Recycling
- Mixed + Contaminated Plastics



CHEMICAL INNOVATIONS FOR Plastics in a Circular Economy

Plastic = Polymer + 'Additives'



Cefic Scope

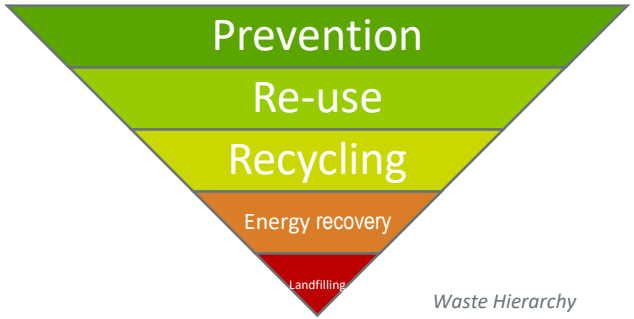
Chemical Recycling

Mechanical Recycling	A	*keep* Plastic	Melt + reshape **Plastic**
Dissolution Recycling	A	*dissolve* Plastic	Keep **Polymer** to make Plastic
Plastic Waste to Monomer Recycling Depolymerisation Solvolysis / Chemolysis	B	*decompose* to Monomer	Polymerise to **new Plastic** ← *Replace non-renewable based monomer*
Plastic Waste to Feedstock Recycling Pyrolysis Gasification *Plastics-Mix*	C	*convert* to Pyrolysis Oil *convert* to (Syn)gas	Produce **new Plastics** ← *Replace non-renewable feedstock*

Chemical Recycling: **What is the Chemical Industry Doing?**

Cefic definition:

- Feedstock recycling, also known as chemical recycling, aims to convert plastic waste into chemicals. It is a process where the **chemical structure of the polymer is changed** and converted into chemical building blocks including monomers that are then used again as a **raw material in chemical processes**.
- Feedstock recycling includes processes such as gasification, pyrolysis, solvolysis, and depolymerisation, which break down plastic waste into chemical building blocks including monomers for the production of plastics.



Waste Hierarchy

Cefic position:

- although conceptually understood, is currently **under-deployed** for plastics circularity
- is an essential and **complementing** step in the complete solution for the circularity of plastics
- **Recycling:** *EU directive 98/2008*

  Any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations

Chemical Recycling: **Cefic CR Position Paper**

The **industry** is operating under the following guiding principles:

- Increase collaboration and work in **partnerships** to boost innovation and investments
- Increase transparency and develop uniform standards for a **mass balance approach**
- Further develop **quality standards** for sorted/pre-treated plastic waste
- **Life Cycle Assessments** (LCA) to measure environmental impacts along the life cycle of products

We invite **policymakers** to integrate into their decisions the following key enablers:

- An enabling **policy framework**
  - Ensure a level playing field with mechanical recycling
  - Develop a clear and harmonised recycling-rate and recycled-content rule throughout the EU
  - Create legal acceptance of a mass balance approach
  - Public sector co-funding to accelerate R&D partnerships
- **Access to feedstock**
  - Harmonised approach for the shipment of plastic waste for use in recycling facilities within Europe

Cefic Position Paper
Chemical Recycling
Published 11 March 2020

cefic

POSITION PAPER

March 2020

Introducing chemical recycling: Plastic waste becoming a resource

"Every year, Europeans generate 25 million tonnes of plastic waste, but less than 30% is collected for recycling" states the 2018 European Plastics Strategy.

The Green Deal is at the heart of the EU's ambitions of becoming climate neutral. To meet the ambitious European objectives, much more waste plastic needs to be recycled and a broader range of markets need to be served with plastic products containing recycled content. In this respect Cefic highlights the potential of chemical recycling of plastic waste. Transitioning from a linear economy to a sustainable circular economy using innovative technologies is a key opportunity for Europe and its industries.

Background

The recycling[1] rate for glass, paper and metal today in the EU is well over 70%. Combinations of different recycling processes, techniques and solutions are in place to achieve these recycling rates. Similarly, in the development of a circular economy for plastics a combination of complementary options will be required to achieve high recycling rates for plastics.

Chemical recycling can fill a void in the plastics recycling loop, conserve valuable resources, and contribute to the creation of low carbon circular economy. Chemical recycling **complements** other plastic recycling options like mechanical and dissolution recycling. It is capable of processing contaminated and/or mixed plastic waste which would otherwise end up in incineration (with or without energy recovery) or landfill. Chemical recycling technologies allow use of plastic waste as feedstock to produce new chemicals and plastics. The quality of the latter is equivalent to those produced from virgin resources, allowing use in high-quality applications such as food contact and food packaging. An added benefit is the potential of chemical recycling to capture and separate the so-called legacy chemicals and substances of very high concern (SVHC) that can be present in end-of-life plastic.

Chemical recycling is not yet a widely deployed option for the recycling of plastic waste. Scale-up requires innovation, harmonised policies, recycling-chains and clear pathways to "valorise" plastic waste that is currently incinerated, landfilled or wasted. The involvement of the entire value chain in combination with a transnational policy framework are key in this respect.

To ensure the scale up and full deployment of chemical recycling, the industry is operating under the following guiding principles:

- **Increase collaboration and work in partnerships to boost innovation and investments**
  - Innovation and Research & Development (R&D) across innovation ecosystems and along the value chains creates the opportunity to address, amongst others operability, impurities – removal of additives / legacy chemicals / substances of very high concern (SVHCs) –

Chemical Recycling: **What is the Chemical Industry Doing?**

Partnerships: Technology Development & Business Case

SABIC PIONEERS FIRST PRODUCTION OF CERTIFIED CIRCULAR POLYMERS

13/02/2019

HOME > NEWS & MEDIA > NEWS ARCHIVE > SABIC PIONEERS FIRST PRODUCTION OF CERTIFIED CIRCULAR POLYMERS

SABIC, a global leader in the chemical industry, has announced another major milestone in its ground-breaking project to pioneer the production of certified circular polymers using a feedstock from mixed plastic waste.

The latest achievement – the production of the first certified circular polymers – is part of what is known as a 'market foundation stage'. Launched in January, this stage is an important step towards creating a new circular value chain for plastics, during which, initial volumes of pyrolysis oil from plastic waste are introduced as feedstock at SABIC's Geleen production site in The Netherlands. The patented pyrolysis oil has been produced by PLASTIC ENERGY Ltd from the recycling of low quality, mixed plastic waste otherwise destined for incineration or landfill.

Dow and Fuenix enter into a partnership for the production of 100% circular plastic

MIDLAND, Mich. & WEERT, The Netherlands - August 29, 2019 - Dow (NYSE: DOW) today announced an agreement with the Fuenix Ecogy Group, based in Weert, The Netherlands, for the supply of pyrolysis oil feedstock, which is made from recycled plastic waste. The feedstock will be used to produce new polymers at Dow's production facilities at Terneuzen, The Netherlands.

The Circular Plastics Alliance To Boost Chemical Recycling

20 September 2019, Brussels. – By signing the Declaration of the Circular Plastics Alliance, the European Chemical Industry Council (Cefic) joins the EU-wide voluntary movement to increase recycling and the uptake of recycled plastics in the EU by 2025.

MEDIA RELEASE // CORPORATE – 08/05/2019

OMV ReOil project: OMV and Borealis extend their partnership at the industrial site in Schwechat

OMV and Borealis are exploring synergies in order to establish a circular economy

The partnership between OMV and Borealis for the petrochemical integration of OMV refineries goes back as far as 1998 and their shared industrial site in Schwechat, Austria, is one of the largest integrated plastics production sites in Europe. The OMV Schwechat Refinery operates integrated petrochemical production facilities and supplies Borealis with petrochemical feedstock. Now OMV and Borealis are taking the next step to advance the chemical recycling of post-consumer plastics.

Joint News Release

BASF invests in Quantafuel to jointly drive chemical recycling of mixed plastic waste

- **Investment is important milestone for BASF's ChemCycling™ project and a further step towards a circular economy**
- **BASF has right of first refusal for chemically recycled pyrolysis oil and purified hydrocarbons from Quantafuel's plant in Skive, Denmark**
- **Joint development of process for production of purified hydrocarbon products is intended**

W2C Rotterdam project welcomes Shell as partner

Shell joins as equity partner with Air Liquide, Enerkem, Nouryon and the Port of Rotterdam

The proposed project in Rotterdam will be the first of its kind in Europe to make valuable chemicals and bio-fuels out of non-recyclable waste materials

Rotterdam, Netherlands, 1 March 2019 – a consortium of world-leading companies comprising Air Liquide, Nouryon (formerly AkzoNobel Specialty Chemicals), Enerkem and the Port of Rotterdam – has announced that Shell will join as a partner in Europe's first advanced waste-to-chemicals facility in Rotterdam, the Netherlands.

LyondellBasell advances chemical recycling by signing agreement with the Karlsruhe Institute of Technology

July 26, 2018

ROTTERDAM, Netherlands, July 26, 2018 – LyondellBasell (NYSE: LYB) one of the world's largest plastics, chemical and refining companies, today announced the cooperation with Karlsruhe Institute of Technology (KIT) to advance the chemical recycling of plastic materials and assist the global efforts towards the circular economy and plastic waste recycling needs. The focus of the venture is to develop a new catalyst and process technology to decompose post-consumer plastic waste, such as packaging into monomers for reuse in polymerization processes.

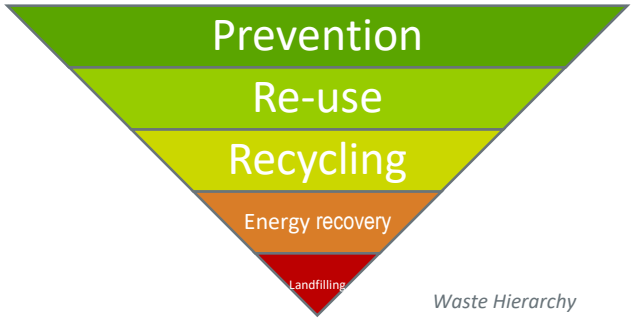
Chemical Recycling: **Relevant EU Legislation**

REACH
- Chemical substance on the market — Regulation 1907/2006

Waste Management
- Landfilling — Directive 1999/31/EC
- Waste Framework — Directive 2008/98/EC
- Packaging and Packaging Waste — Directive 94/62/EC
- Single Use Plastics — Directive 2019/904

Food Contact
- Plastic materials — Regulation 10/2011
- Recycled Plastic Materials — Regulation 282/2008

Incentives
- Non-Recycled Plastics Packaging Waste — Tax 0.80€/kg



Waste Hierarchy

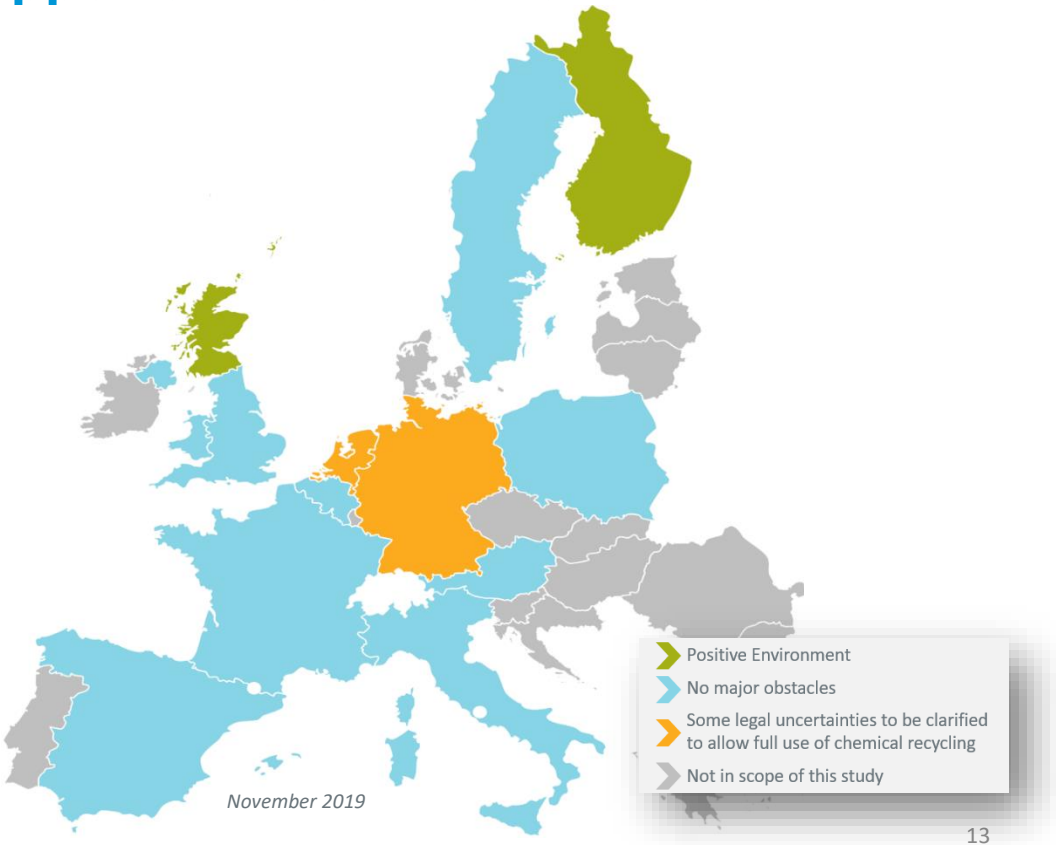
Chemical Recycling:
Challenges and Opportunities at National Level

Cefic Study November 2019

Recycling:
- Similar and in line with the EU Waste Framework Directive
- Differences observed in National Waste Plans (*in revision*)

Chain of Custody & Mass Balance:
- No country has considered an approach based on mass balance specifically
- Current systems only set traceability requirements (amount, origin, destination, transfer date, etc.)

End of Waste:
- End of waste criteria are similar, however not harmonised



Chemical Recycling: **Answering some Questions**

Competing with mechanical recycling	Cefic position	**Complementing** + needing both
Chemical “Recycling” producing **fuel**	Cefic position	**not Recycling**
GHG footprint	Cefic LCA study	**Publishing** soon
Recycled content *(Qualitative & Quantitative)*	Chain of Custody	**Segregating** or **Attributing** using Mass Balance
Not proven at **full scale**	Technology	Ready & **Demonstrating**
Can **not compete** in market	Business case	Partnerships & **Testing** in market

Can we achieve a Circular Economy for Plastics ***without Chemical Recycling?***

Resources:

- Middle East: oil + gas
- US: shale gas
- Europe: end of life materials **=** **products and secondary raw materials**

Europe can take a leadership role in the development of the circular economy

- **(Chemical) Recycling** is an integral part of a circular economy

Shift from a "waste orientation" to a "resource orientation"
& Create a single market for secondary raw materials

Thank you