Circular Plastics: Options, Threats and Opportunities for the European Petrochemicals and Plastics Industry

TNO innovation for life

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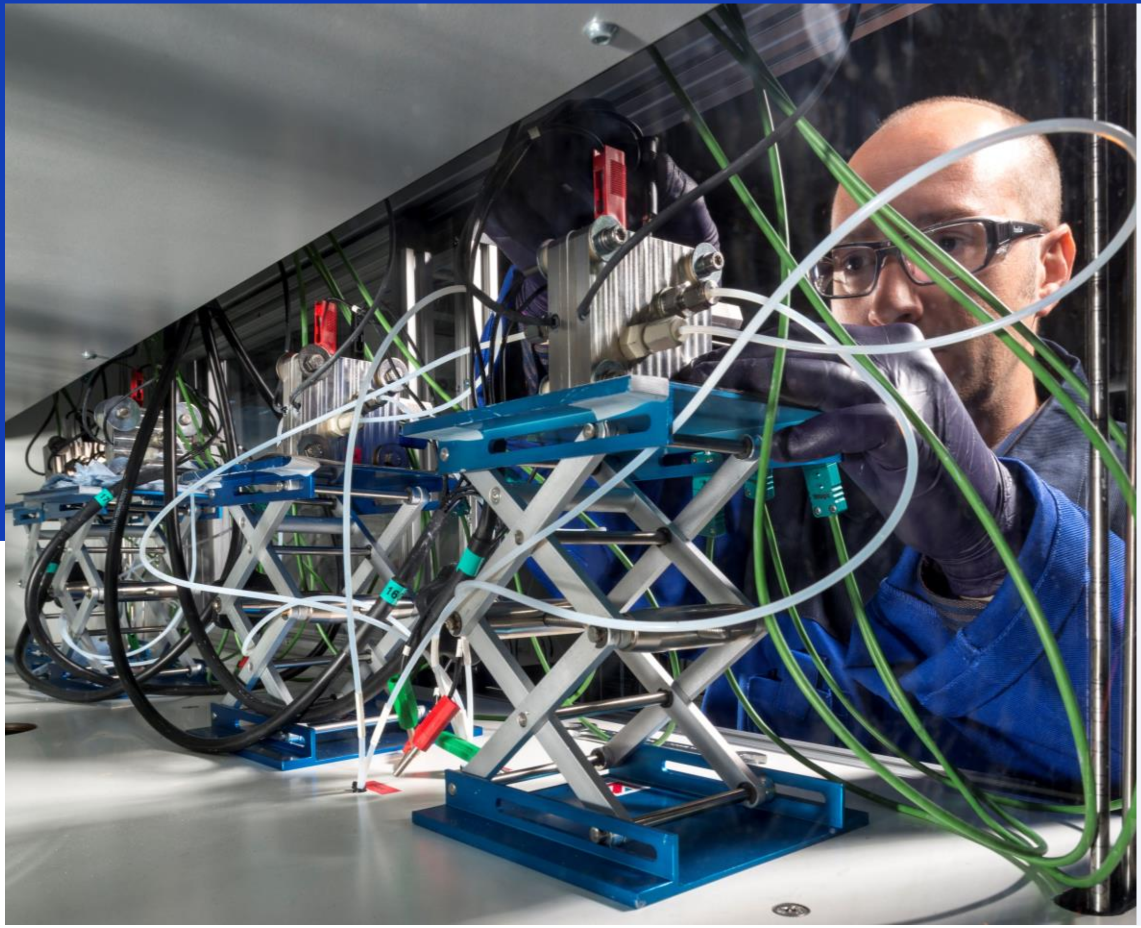
Talk Outline



1. Megatrends & Long-Term Outlook
2. European Chemical & Plastics Industries
3. Risks, Options, Opportunities
4. Technology Pathways
5. 2030 Scenario
6. Summary

The Two Megatrends: Climate and Circular Economy

UNITED NATIONS
PARIS CLIMATE AGREEMENT
SIGNING CEREMONY
22 APRIL 2016

a long-term goal of keeping the increase in global average temperature to well below 2°C above pre-industrial levels

to aim to limit the increase to 1.5°C

on the need for global emissions to peak as soon as possible, recognising that this will take longer for developing countries

2050

EUROPEAN PLASTICS PACT

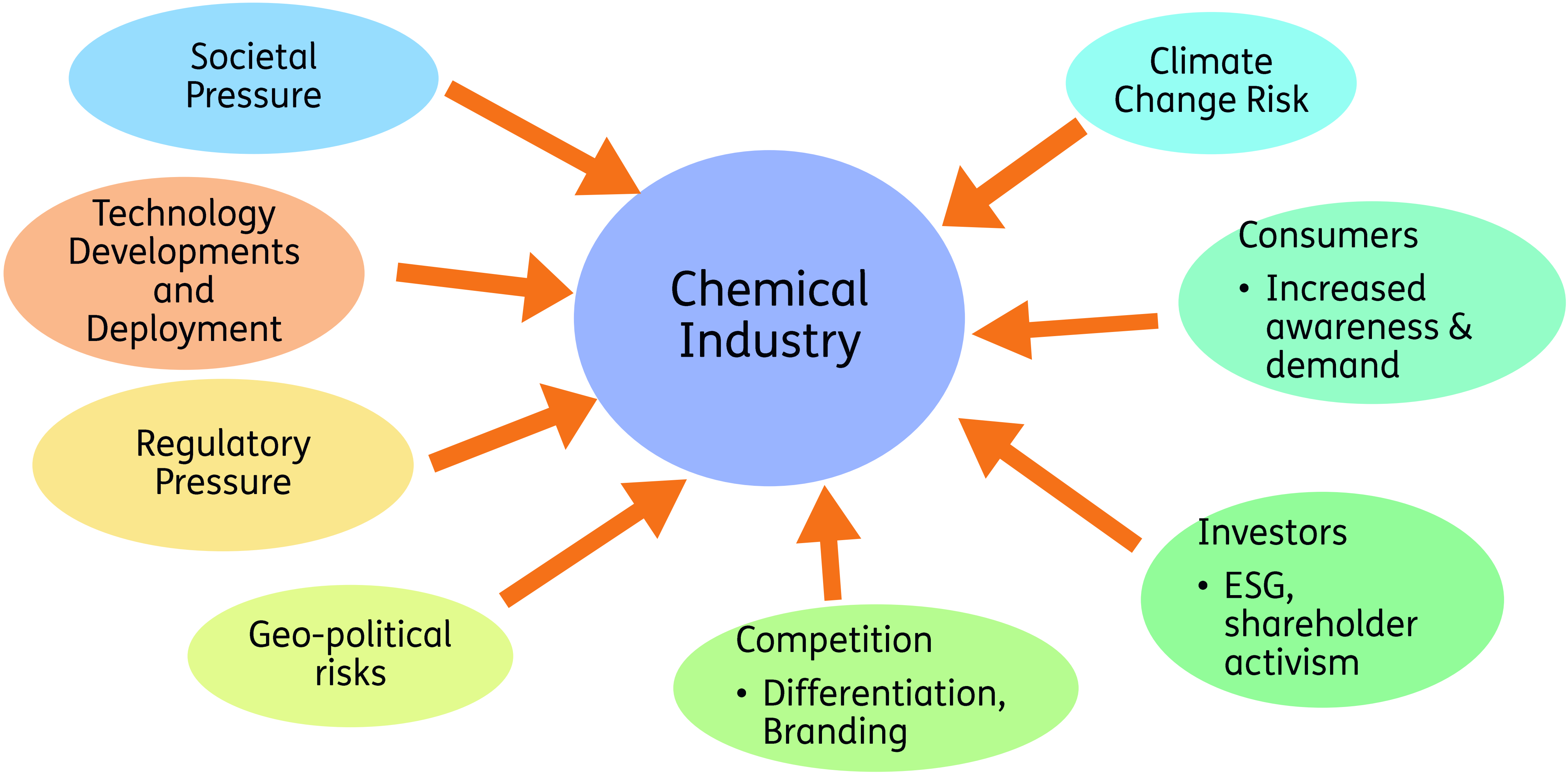
Aiming for a reduction in virgin plastic products and packaging of at least 20% (by weight) by 2025

half of the 20% reduction coming from an absolute reduction of plastics

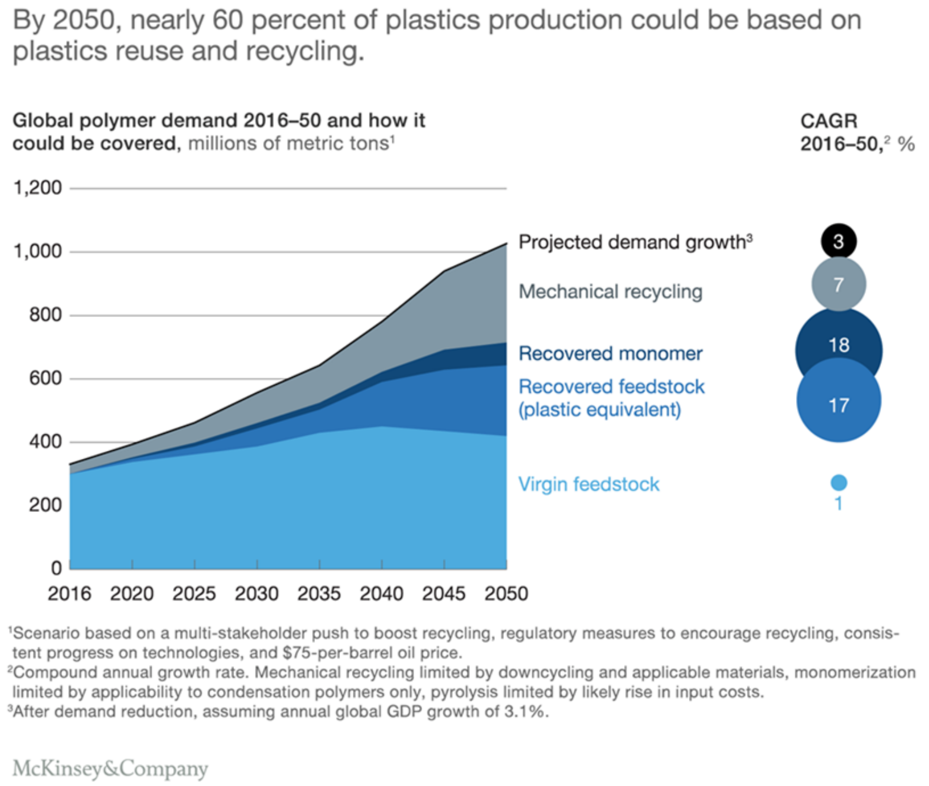
Achieving an average of at least 30% recycled plastics (in weight) in plastic product and packaging range

2025

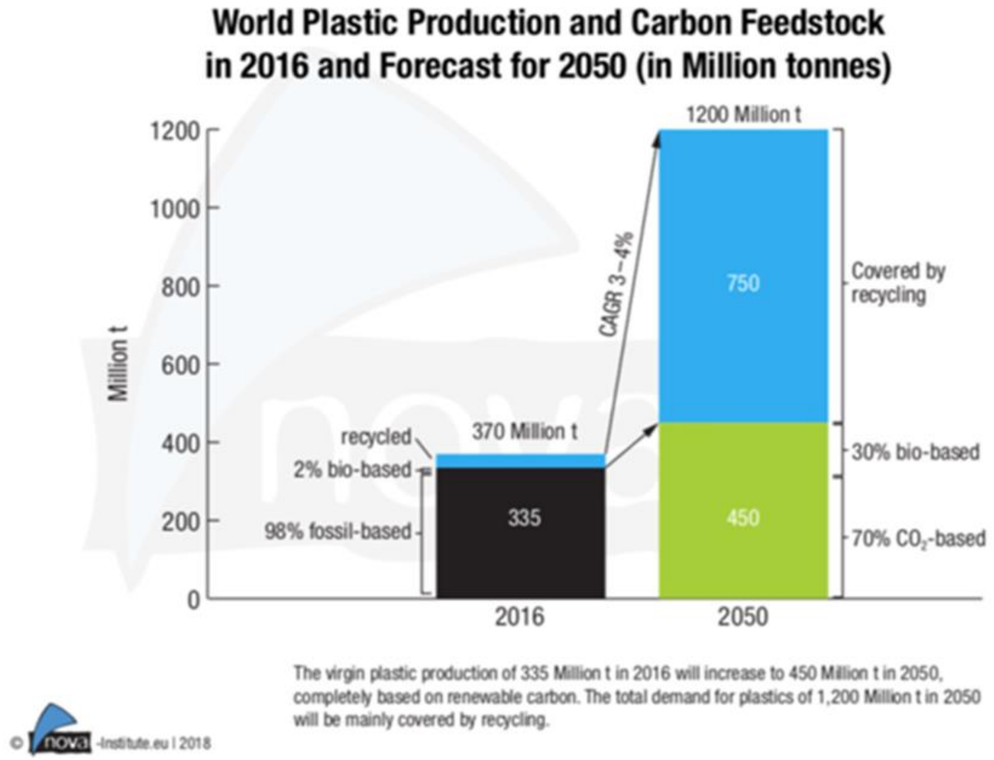
Forces Driving Circular Economy In Chemical Industry



2050 Outlooks



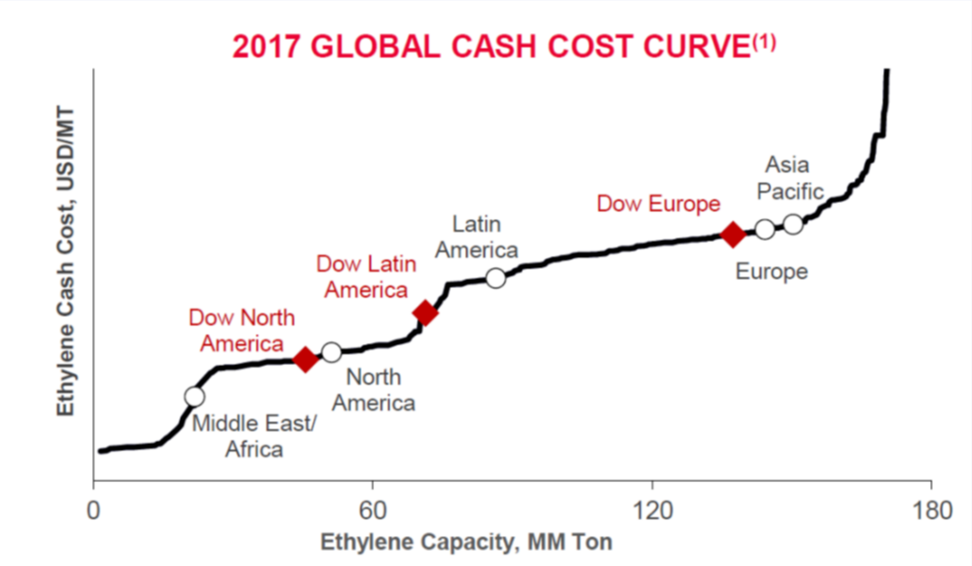
Ref: 1) Mckinsey & Company report, December 2018

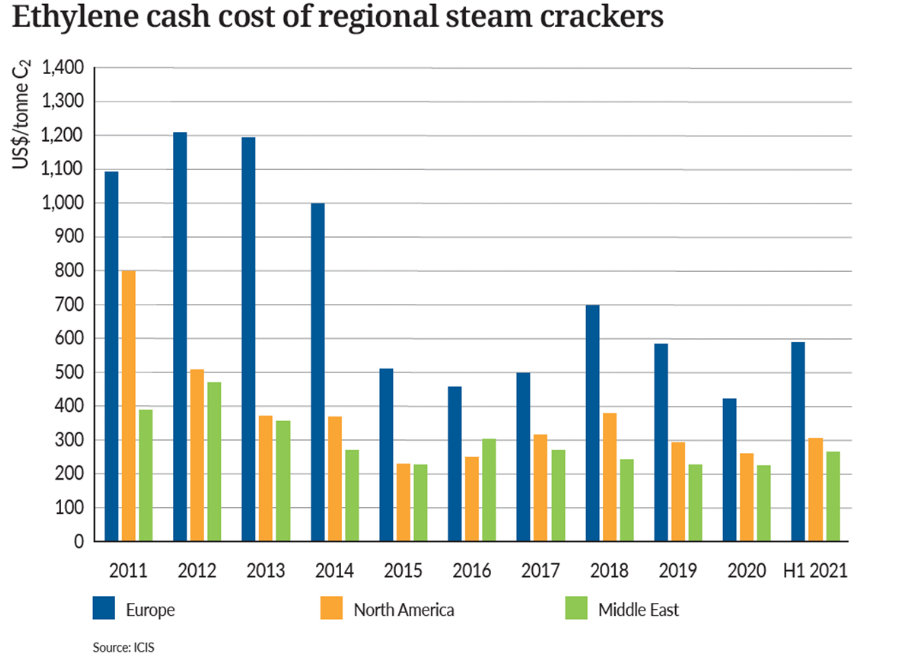


Ref: Nova Institute Report, 2019

Different Assessments - Similar Narrative
Momentum shift towards Circular Economy and Decarbonization

Ethylene Cash Cost Curve





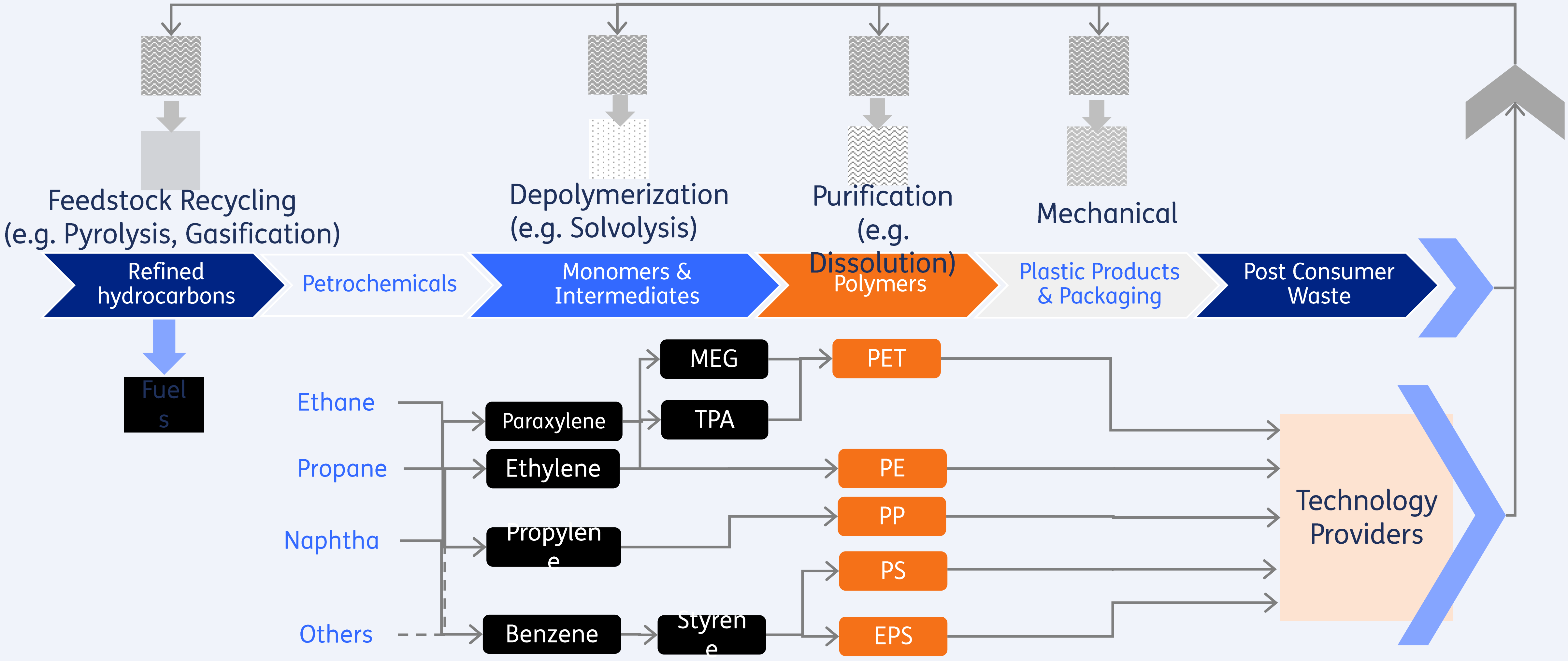
- European crackers are on the right side of the cost curve
- Middle East & US have low-cost feedstock (Ethane) advantage with additional new capacities planned/under construction
- European Plastics industry will be threatened by cheaper imports from the US

Need for European Plastics Industry to Differentiate

References: 1) “New DOW”, PRE-SPIN INVESTOR ROADSHOW Presentation, March 2019.
2) ICIS Chart on ethylene cash cost of regional steam crackers.

Circular Economy	Risks	Opportunities
Business Model	Redesigning the business around a circular approach	Business model and supply chain redesign
Regulations, Geopolitical	Geopolitical tensions & limited regulatory support Low carbon price/carbon tax Plastics to fuel	Regulatory support on CE High carbon price/carbon tax Scope 3 GHG savings credit?
Market	Import of chemicals/plastics into EU Cost competitiveness, supply chain, Competition with biofuels	High crude oil prices Differentiation / Premium Growing demand Low barriers for entry
Technology	Many technologies under development Long technology development time Winning technologies? Product quality, food grade applications	New Product/Process development Design Supply chains Digitization
Cultural	Lack of awareness/willingness/agility to engage with CE	Demonstrate leadership

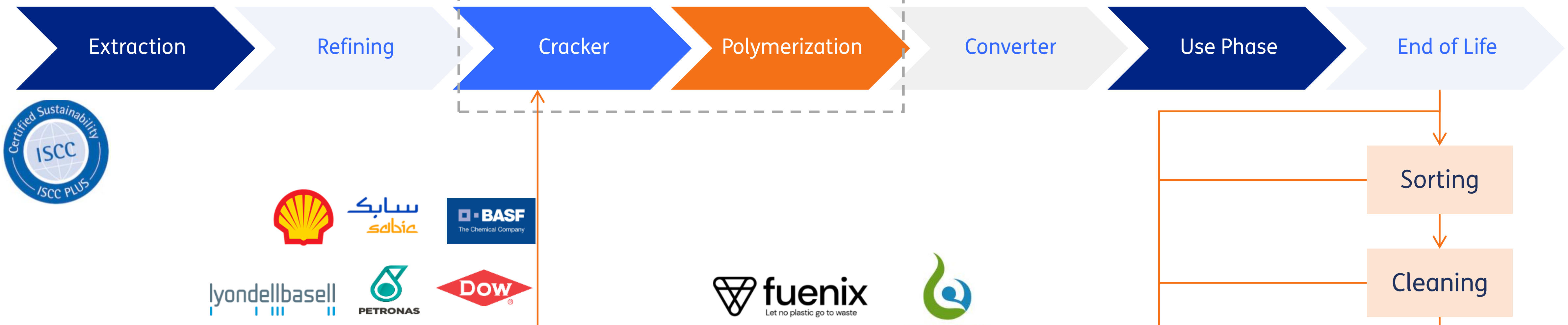
TECHNOLOGY PATHWAYS FOR CIRCULAR PLASTICS

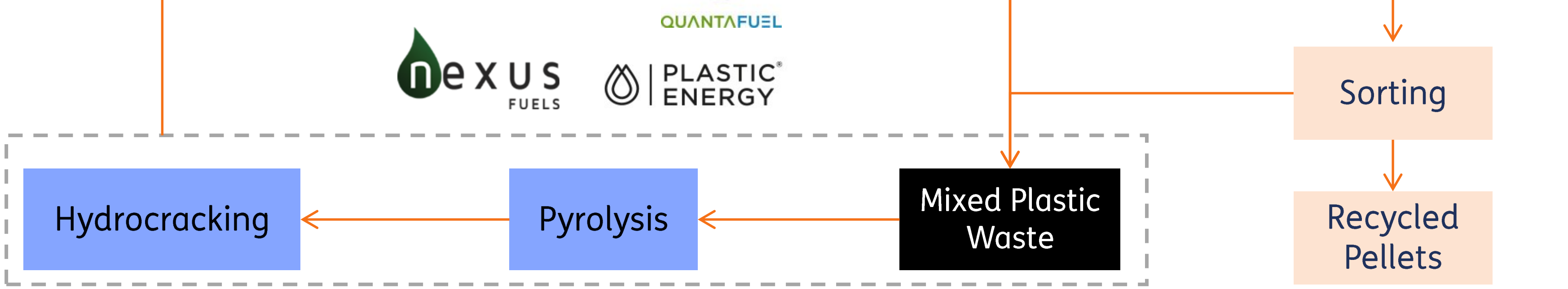


Reference: “ACCELERATING CIRCULAR SUPPLY CHAINS FOR PLASTICS”, CLOSEDLOOPPARTNERS”

Example – THERMAL CONVERSION (Pyrolysis)

Mixed plastic waste streams to chemicals, plastics value chain





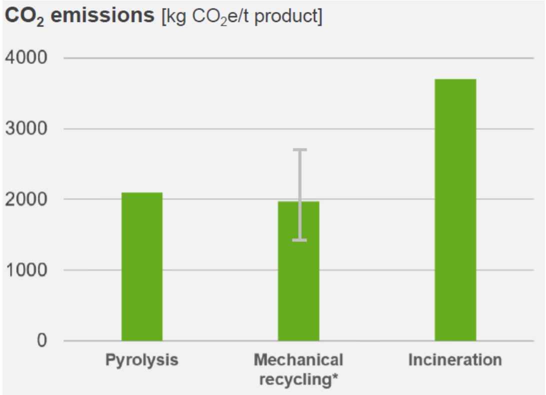


Fig. 3: Production and end-of-life treatment of 1t of plastics via pyrolysis emit 2,100 kg CO2e, whereas production and end-of-life treatment of 1t of plastics via mechanical recycling emits 1,973kg CO2e. Production and incineration of 1t of plastics emits 3,700 kg CO2e.

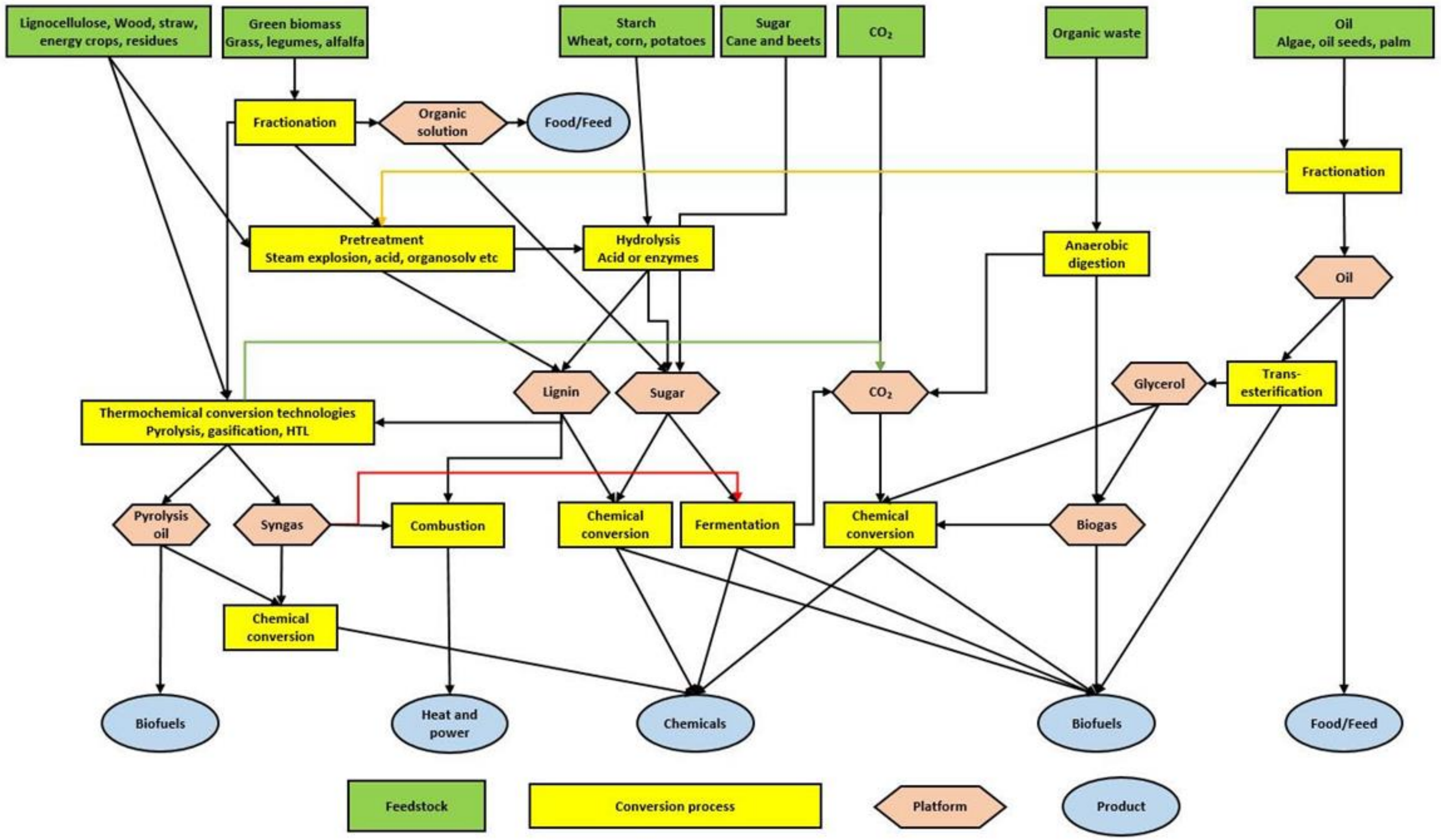
* The error bar reflects the different scenarios by changing the quality factor and the material loss rates after sorting of waste

*CE Deft Study: "Exploration chemical recycling – Extended summary – January 2020"; Avoided CO2 benefits included (products/energy)

Platforms for bio-chemicals production

8 platforms

- Pyrolysis oil
- Bio-Mass Balance Approach
- CO2 Platform
- Syngas Platform
- Sugars
- Lignin
- Bio-Oil Platform
- Organic Solution Platform



8 Platforms | Multiple Pathways | High Complexity & Risks For Placing Bets On Winning Technologies

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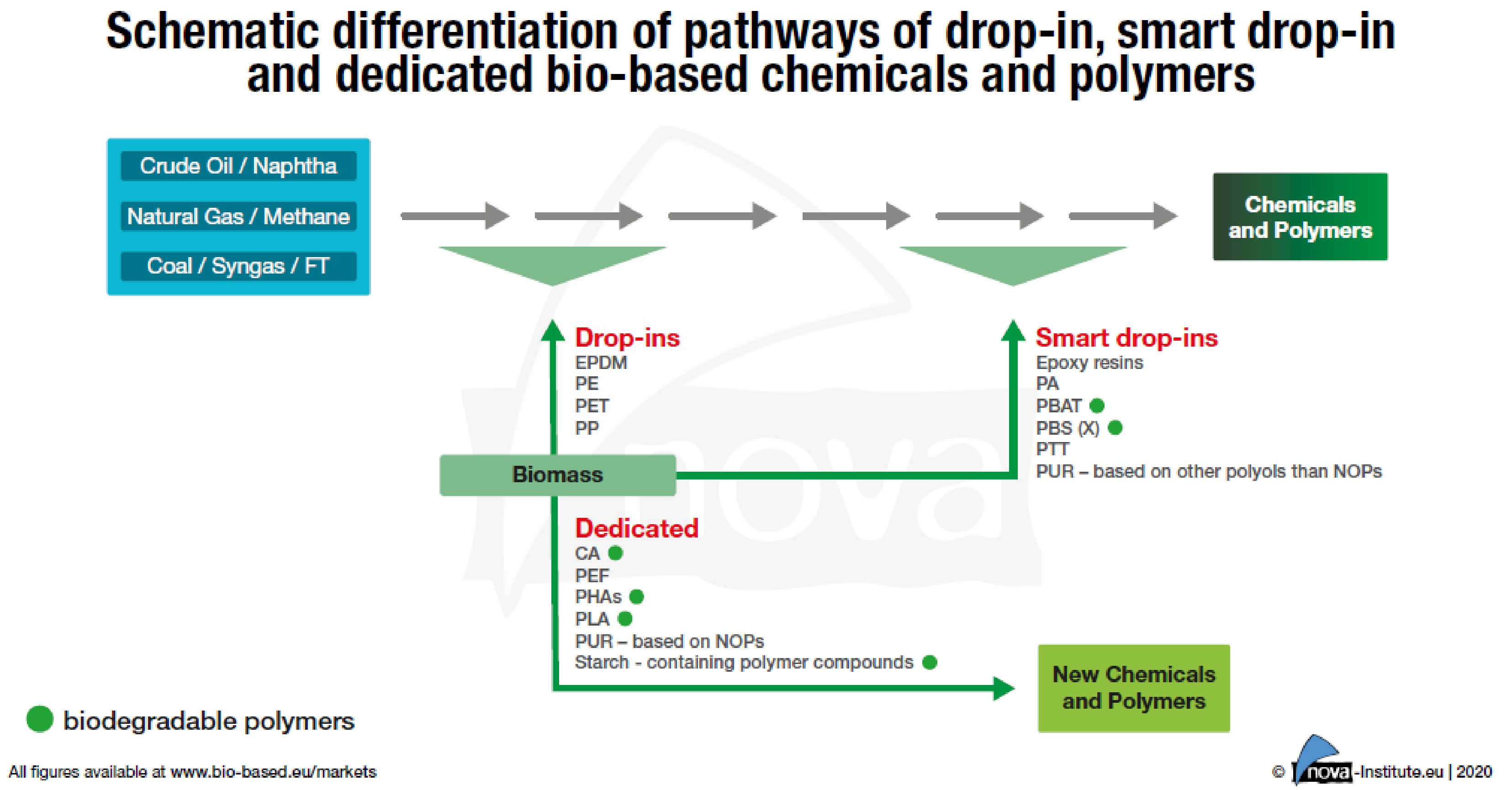
Reference: IEA Bioenergy: Task 42: 2020: 01, Bio-Based Chemicals- A 2020 Update

All possible pathways need attention by the industry



- Smart drop-ins need business development and market pull
- Dedicated bio-based pathways need technology development

Reference: Bio-based Building Blocks and Polymers – Global Capacities, Production and Trends 2020 – 2025 – Graphics: Figure 5

Example – biobased drop-ins

Bio-polyethylene from waste animal fat or crude tall oil

Waste Animal Fat

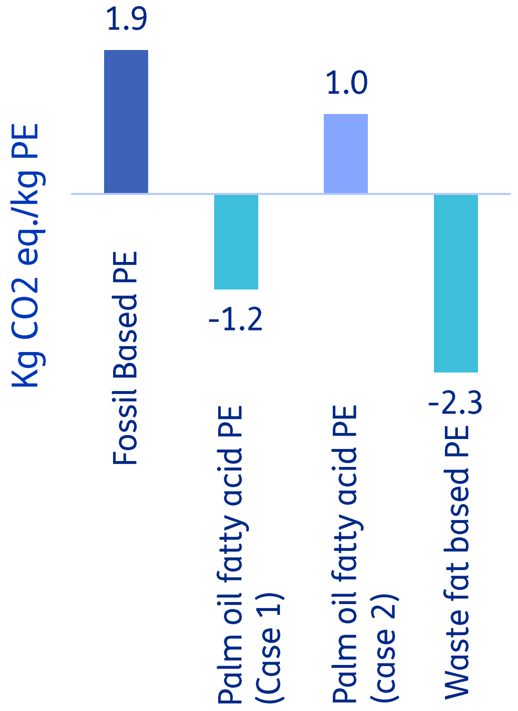
Crude Tall Oil

Bio-refinery

Hydrotreatment

Drop-Ins

PE Carbon-Footprint (Cradle to Gate)*



Bio-feedstocks
Waste animal fat
Waste fat from fish industry
Vegetable oil residues (Stearin, PFAD)
Technical corn oil
Tall oil pitch
Soybean oil
Crude palm oil
Camelina oil
Jatropha oil
Rapeseed oil
Used cooking oil

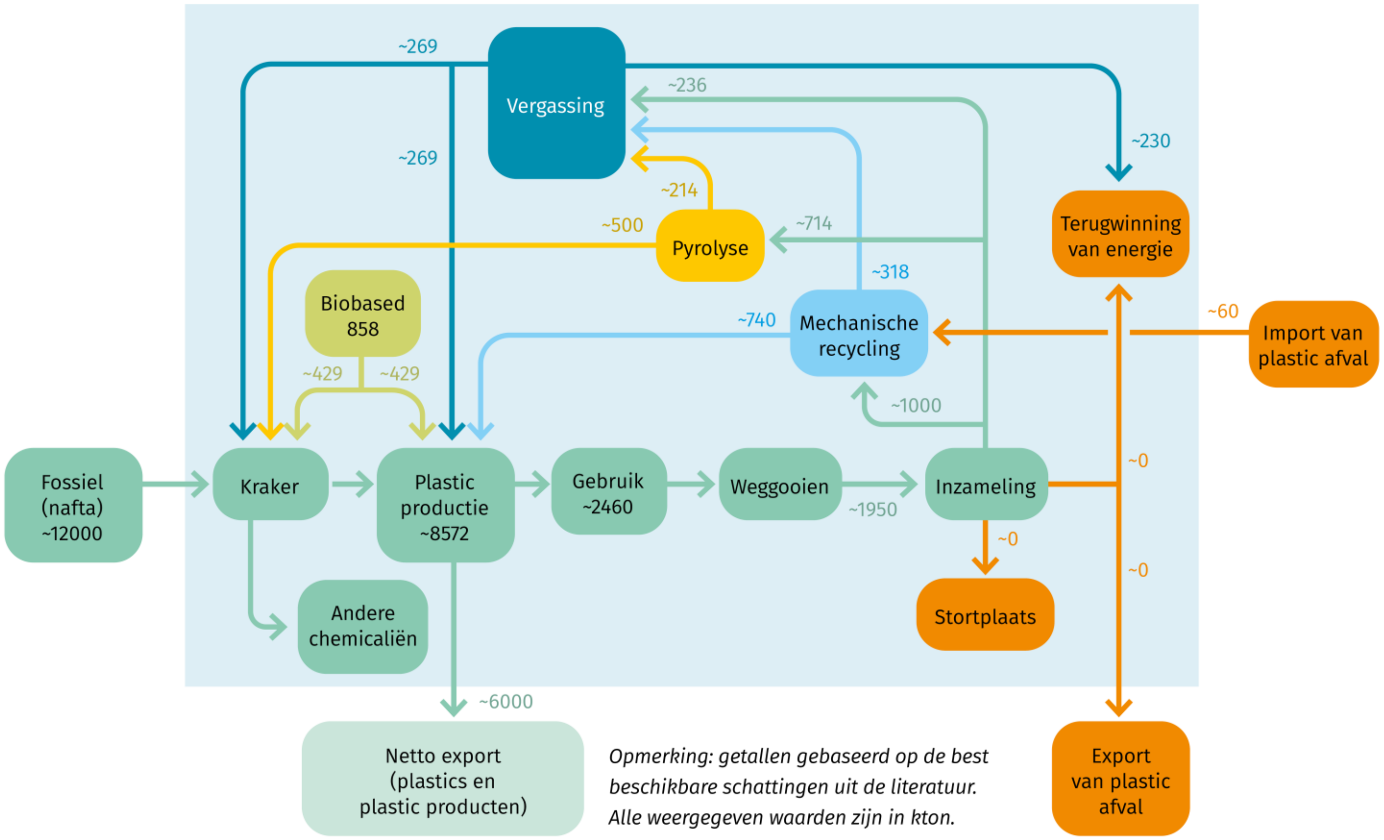
Extraction → Refining → Cracker → Polymerization → Converter → Use Phase → End of Life

*Literature Report, ICCA Avoided Emissions Case Studies Report, 2017.

Plastics Flows In The Netherlands

2030 Scenario | No Imports Of Waste Plastic Feedstock

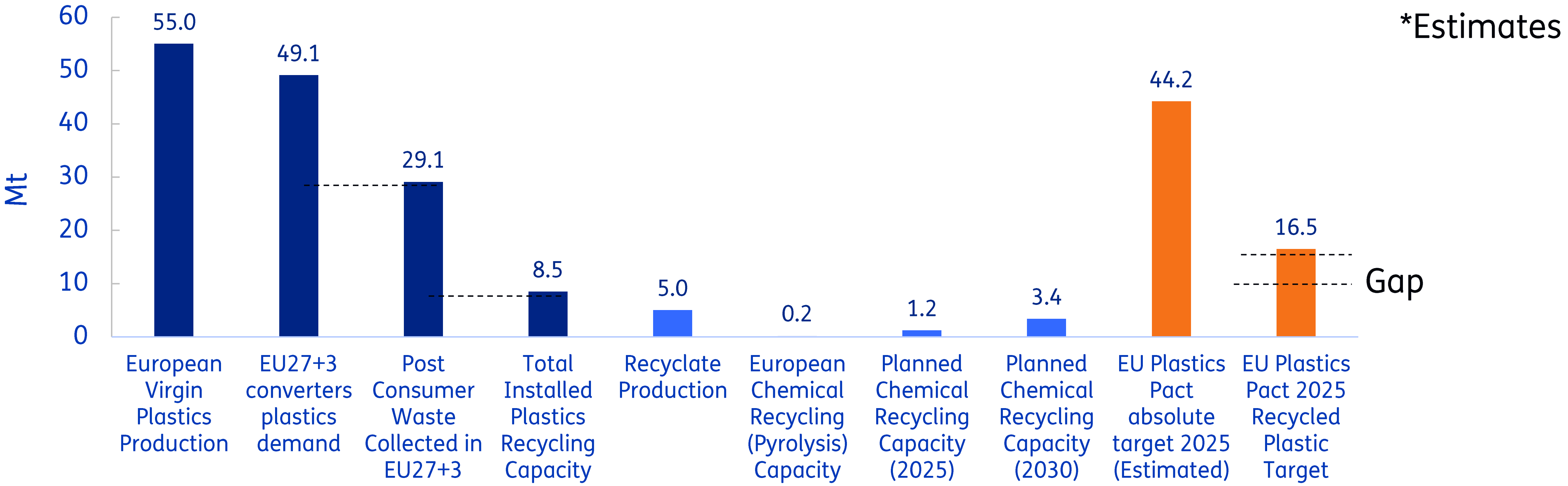
Afbeelding 4: *Vereenvoudigd schema van de voor 2030 verwachte plastic-stromen in Nederland*[13].



Note: Numbers based on the available estimates from the literature. All displayed values are in kton.

- Efforts to meet circularity targets will contribute towards climate change goals
- However, meeting 2030 circularity goals will likely not be sufficient to meet climate goals for the Dutch petrochemicals industry

Recycled plastics Demand, Capacity Mismatch



- European reprocessing and mechanical recycling have room to scale up significantly.
- Additional recycling capacity is being added rapidly and several announcements have been made for new recycling plants in Europe- mechanical, depolymerization, and pyrolysis.
- However, most of these announcements are for investments after 2025 and 2030 (pyrolysis, depolymerisation, dissolution). Therefore, short to medium term the recycled plastics market will continue to be tight.
- Risk of xx% idle virgin plastic (& cracker) production capacity in Europe by 2030.

Sumarry

“It is not the strongest, nor the most intelligent species that survive, but the one most responsive to change”
- Charles Darwin

Thank you

Download our latest whitepaper "Pathways to sustainable plastics Unlocking opportunities in biobased plastic".

Join our webinar on 11 March 2025 for exclusive insights and expert discussions on Pathways to sustainable plastics.

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