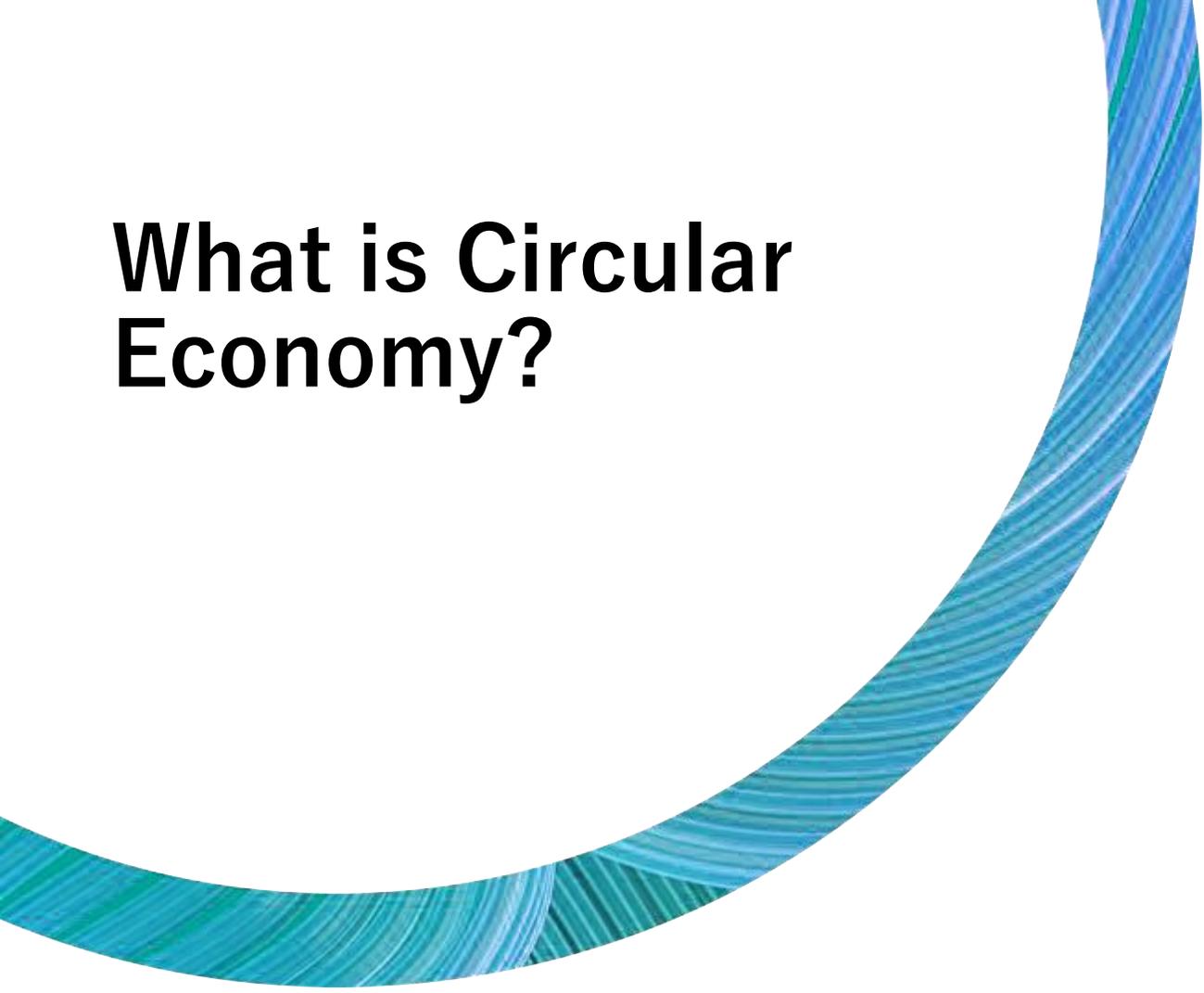


# **Circular Economy** at Mitsubishi Chemical in Europe

# What is Circular Economy?



As part of the EU Green Deal, a Circular Economy is an initiative to transform Europe into a modern, resource-efficient, and competitive economy by...

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prioritising design for **durability, reusability, upgradability, reparability or recyclability** of products

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increasing **recycled content** in products

---

enabling remanufacturing and **high quality recycling**

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reducing **environmental footprint**

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incentivising **product-as-a-service** business models

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offering **safe-by-design chemicals**

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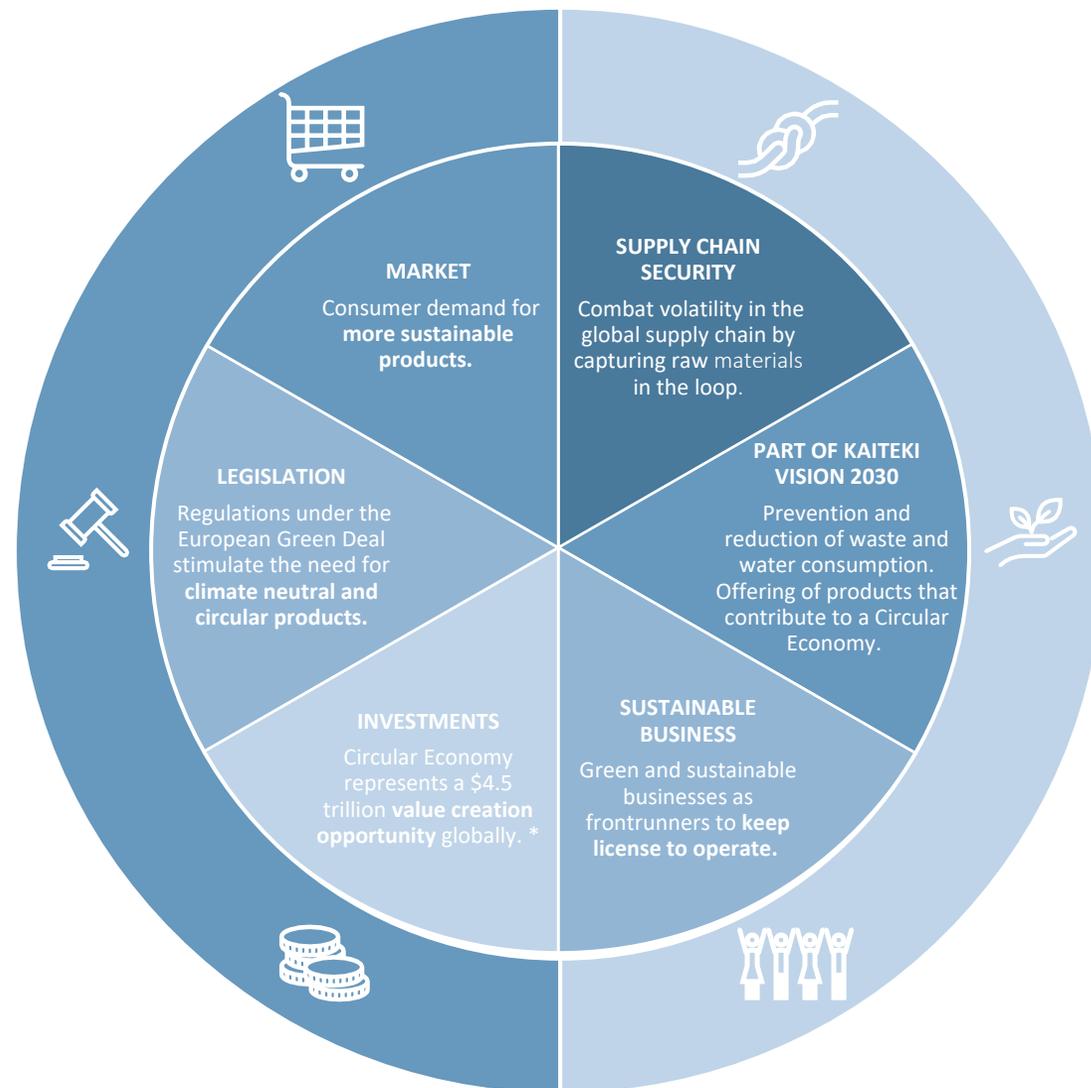
**digitalising** product information

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Source: [A new circular economy action plan for a cleaner and more competitive Europe](#)

# Why do we need to work towards a Circular Economy?

- Internal Factors
- External Factors



\* According to [Accenture](#)

# We are realising KAITEKI

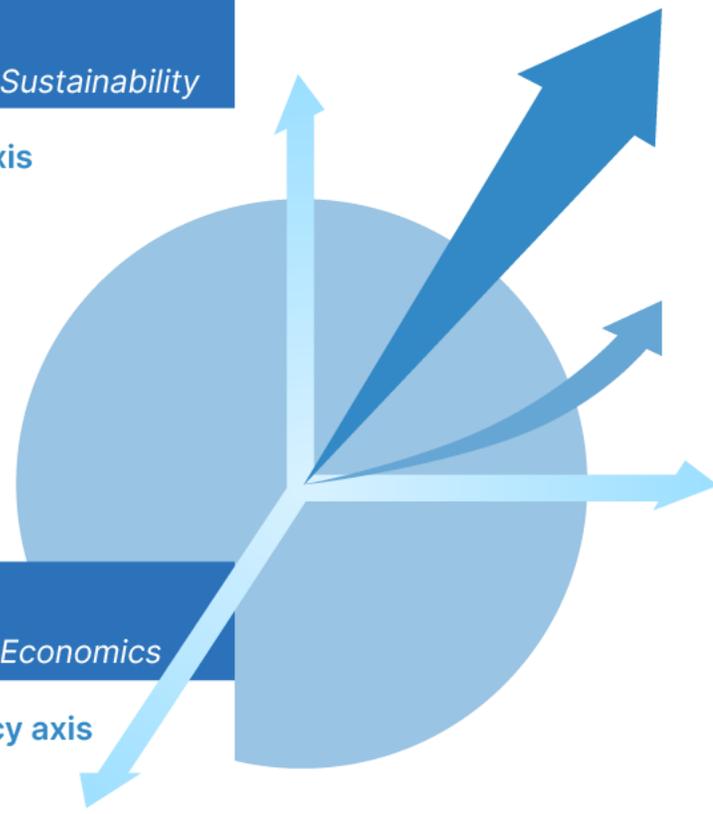


**M.O.S.**  
*Management of Sustainability*

Sustainability axis

**M.O.E.**  
*Management of Economics*

Capital efficiency axis



**KAITEKI Value**

Time  
Taking into consideration signs of the time

**M.O.T.**  
*Management of Technology*

Innovation axis

# KAITEKI Vision 2030

## What do we want to achieve?

Build a sustainability management system



Measurement of financial, social and environmental impact along the life cycle



Reduce environmental impact



Promote a circular economy



Feasibility studies of KAITEKI factories



## What are our key measures?

We foster sustainable and responsible corporate behaviour throughout global value chains.

We make the environmental impact of our products measurable through life cycle assessments.

We will achieve carbon neutrality by 2050 with net zero greenhouse gas emissions. We will contribute towards a non-toxic environment.

We take measures to prevent and reduce waste and water consumption in-house and offer a product portfolio that contributes to a Circular Economy.

We use innovative technologies in our factories that contribute to KAITEKI.

# Mitsubishi Chemical Corporation: Our global path to reduce greenhouse gas emissions



Scope 1 & 2

**32%**

**Minimum reduction of  
greenhouse gas emissions**

By 2030 compared to 2019

Scope 1 & 2

**0%**

**Net zero greenhouse gas  
emissions**

By 2050





# Evaluating the environmental impact of our products

We have established life cycle assessment (LCA) capabilities to calculate the **environmental footprint of our products**.

Together with our partners along the value chain, we work to **reduce the environmental impact** of our products.

We have founded a **Global LCA Competence Center** to harmonise our LCA evaluation and reporting methodology based on global ISO standards and regulations among each region of Mitsubishi Chemical Group.

# Our roadmap to a Circular Economy in Europe



Circular Economy is the key to realise our sustainability vision.

**KAITEKI** is the basis for all our business operations: a belief in realising the sustainable well-being of people, society and our planet Earth.

At Mitsubishi Chemical Corporation

- We support the objectives of the **Green Deal**.
- We aim to reduce our global greenhouse gas emissions **by at least 32% by 2030**.
- We are committed to achieving **net zero greenhouse gas emissions by 2050**.

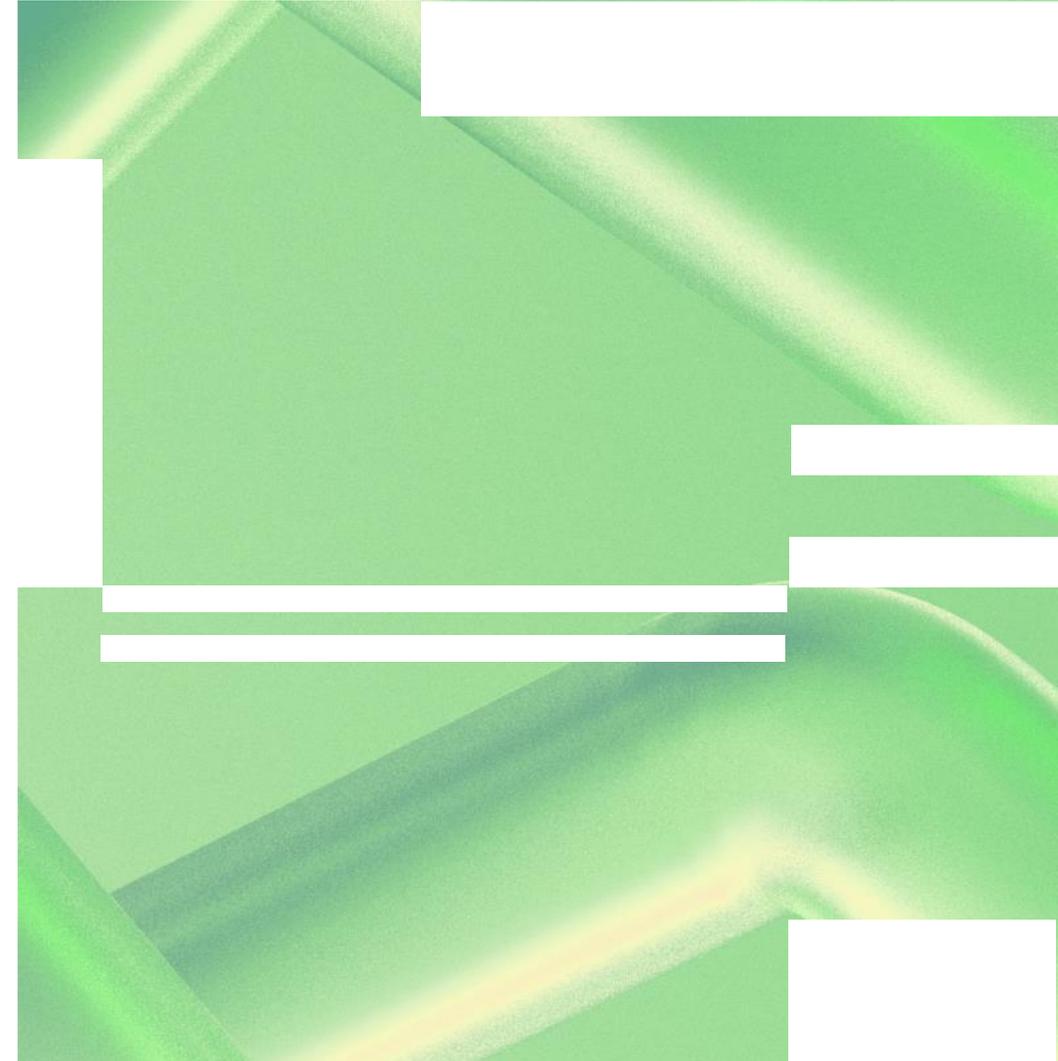
# Our roadmap to a Circular Economy in Europe



To achieve our ambition, we promote a Circular Economy in our European businesses

- by **minimising waste** throughout the product lifecycle;
- products made from **biobased or recycled content**;
- developing new **circular business models**.

Working together with our **value chain partners**, we will create new value by promoting a comprehensive, systemic transformation that benefits the environment, economy and society.



# In 2020...

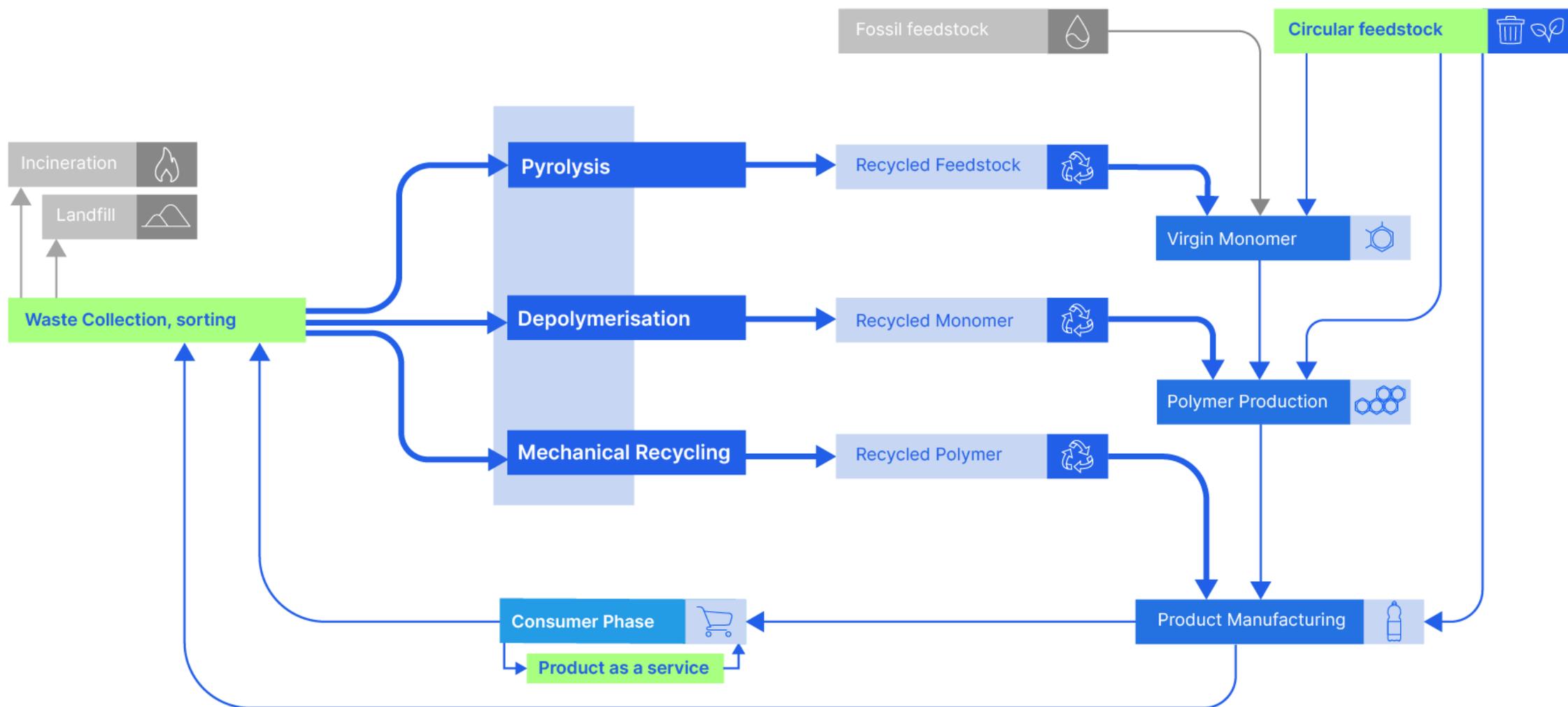


## ...we founded a global Circular Economy Department

**Operating across all business domains** to propose circular economy solutions, work on business cases and products to develop them into business.

**Collaborating with different stakeholders** like customers, business partners, academia and start-ups to realise our 2030 sustainability vision.

# Overview of Circular Economy Technologies

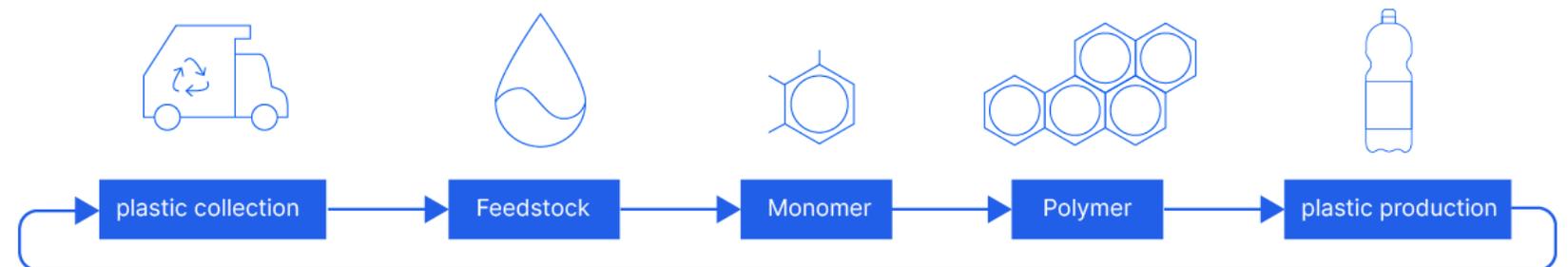


# Pyrolysis: Chemical Recycling of plastic waste



In collaboration with ENEOS, we are working to industrialize Mura Technology's pyrolysis capabilities and implement a **plastic-oil conversion facility** at our Ibaraki plant in Japan.

For the supply of waste feedstock, we cooperate with the **local waste operator** REFINVERSE group.



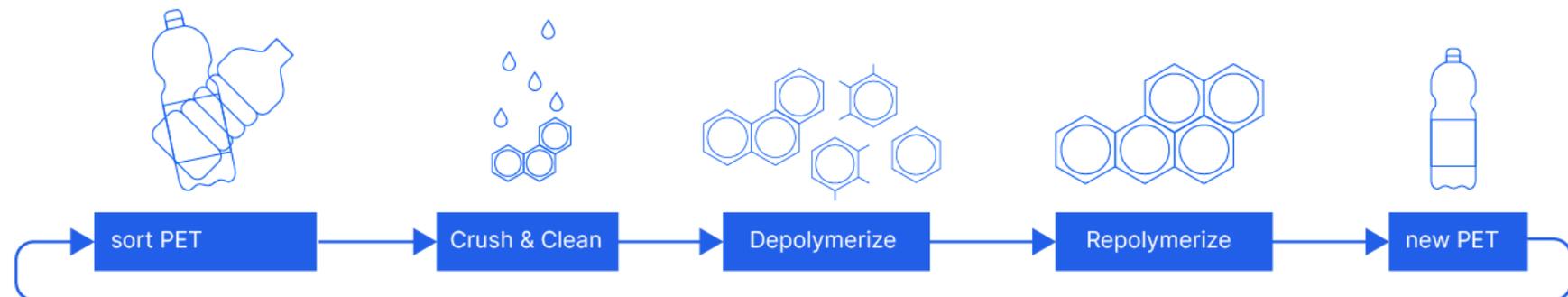
# Depolymerisation of PET



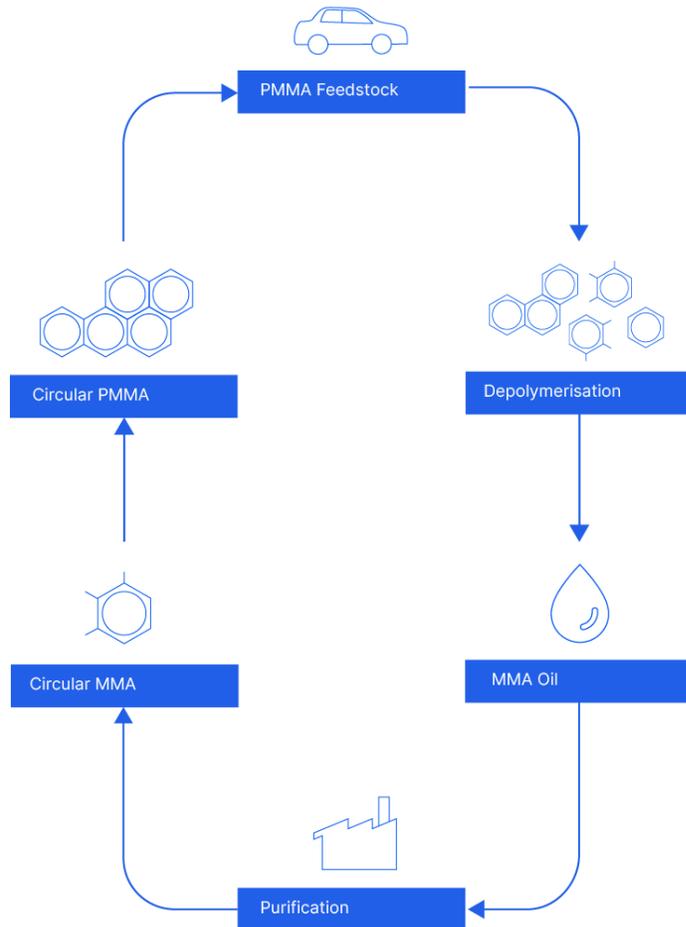
In 2020, we started a cooperation with the Japanese beverage manufacturer Kirin Holdings to develop applications for a chemical recycling technology specifically designed to reclaim **PET products and scrap materials** discarded from factories and other sources.

The system will involve collecting the used products, converting them to raw PET material via chemical recycling, and then producing new PET products from the recycled materials.

This chemical recycling project launched in Japan.



# Depolymerisation of PMMA feedstock at Mitsubishi Chemical Methacrylate in Europe



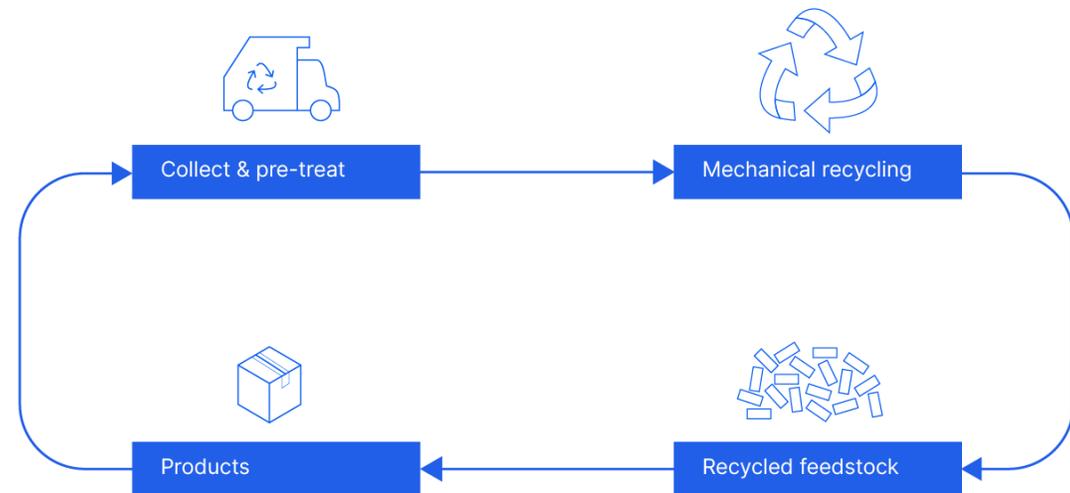
- Unlike most other polymers PMMA is a unique material. Through a **depolymerisation process called molecular recycling**, it easily breaks down to its original molecule, MMA. Mitsubishi Chemical Methacrylate plans to open a European recycling plant for depolymerising PMMA to MMA.
- According to an internal theoretical study, it is estimated that circular acrylic products have a **70% lower carbon footprint** than virgin grades.
- PMMA has the exceptional property that, when heated to a critical temperature, its polymer chains break and revert to the monomer. This temperature is far lower than what is required for pyrolysis. Because of this, PMMA has a **very high recovery rate and recycling potential**.

# Mechanical recycling of Thermoplastics in Europe



Our Advanced Materials - Recycling Solutions division is a **pioneer in producing circular feedstock** and offers a variety of products made from post-industrial thermoplastic waste.

We can process standard and advanced engineering plastics including **PEEK, Fluoroplastics and Polyamides.**





## Extend the loop with services from Cleanpart

Cleanpart offers a turnkey solution with focus on providing cleaning and specialty coating services for **semiconductor equipment parts**. They are the largest provider of such services in Europe.

Cleanpart services maximise the economic value of equipment parts and **save valuable resources by reducing the need for virgin materials**. As such, they contribute to a reduction in the environmental footprint of semiconductor industry products.

# Product solutions – We drive a Circular Economy in four key areas



## Circular feedstock:

Keep existing feedstock in circulation and out of the environment. Replace non-renewable/non-recyclable/polluting feedstock with renewable/recycled feedstocks from sustainable sources.

## Design for circularity:

Develop new products specifically designed to have a circular life cycle.

## Close the loop:

Innovate existing material cycled to ensure that the amount of reusable, recyclable, biodegradable and/or bio-based feedstock increases.

## Extend the loop:

Improve production processes and materials to extend products life cycles, reducing the consumption of materials and prolonging wear out.

# Driving a circular economy & improving sustainability in Europe

Developing products that make a positive contribution to our planet earth

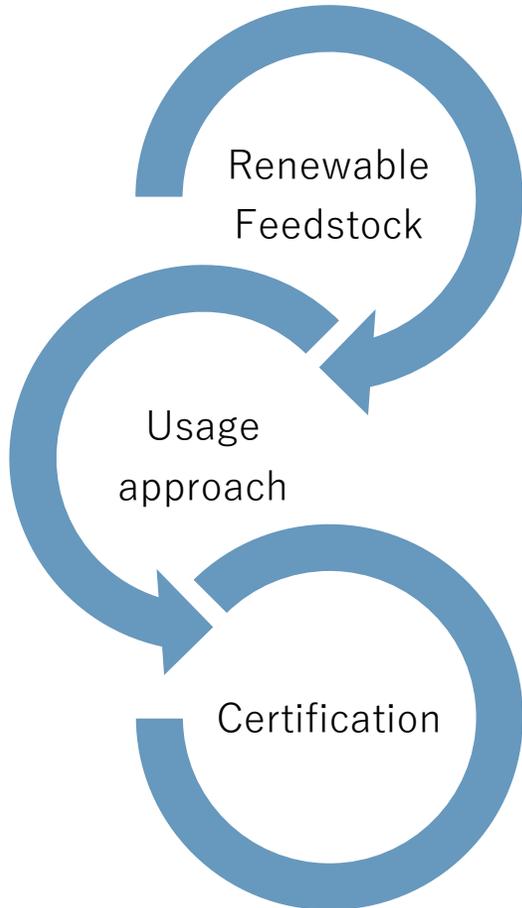


INDUSTRY	CE CATEGORY	<b>CIRCULAR FEEDSTOCK =</b> keep existing feedstock in circulation and out of the environment. Replace non-renewable/ non-recyclable/ polluting feedstock with renewable/ recycled feedstocks from sustainable sources	<b>DESIGN FOR CIRCULARITY =</b> develop new products specifically designed to have a circular life cycle or products considered to be recyclable according to third party laboratories	<b>CLOSE THE LOOP=</b> Innovate existing material cycles to ensure that the amount of reusable, recyclable, biodegradable and/ or bio-based feedstock increases	<b>EXTEND THE LOOP =</b> Improve production processes to extend the products' life cycle to reduce consumption of materials and prolong wearout	<b>CE LIGHTHOUSE PROJECTS</b>	
MOBILITY & EV						Circular acrylic from acrylic waste by depolymerisation of PMMA to MMA	
						Marvyflo™, TEFABLOC™ TG, VINIKA™ VG - Circular compounds with recycled or biobased content	
						CarboNXT® recycled carbon fibre materials	
RESINS&FILMS						Nichigo G-Polymer™ to recycle multilayer packaging film and to extend the shelf life of a product	
						BIOPBST™ – biobased polybutylene succinate which is biodegradable for specific applications and in dedicated facilities	
						Hostaphan® PCR – polyester film with 30-70% post-consumer recycled resin	
ADDITIVE PRINTING						Soarno™ (EVOH) and Modic™ tie resin – mechanical recyclability of multilayer packaging film	
						Cleanpart provides cleaning and specialty coating services which save resources and extend the lifetime for semiconductor equipment parts	
INNOVATION INDUSTRIES						Metablen™ is an impact modifier for the mechanical recycling of plastics. It also can be used to improve the technical properties of polymers to extend the life cycle	
						Sterra grades - a portfolio of sustainable high-performing plastics as shapes or parts containing recycled material	

Lighthouse projects

# Circular Feedstock

# Circular feedstock use in compounds in Europe



**Renewable carbon feedstock** is an alternative to fossil feedstock that can be issued from biobased materials (biomass), circular materials (recyclates) or biocircular materials (biological recyclates).

**The Performance Division in Europe** can use partly or totally renewable carbon-based ingredients in order to progressively reduce the use of fossil-based materials. Incorporation can occur directly (physical segregation) and/or using the Mass-Balance approach, through strict bookkeeping along the supply chain.

**Certification** such as ISCC+ is available in some of our factories in order to guarantee the proper use and flow of sustainable materials into the supply chain, as well as to maximise the value and sustainability benefits for all the certified stakeholders.

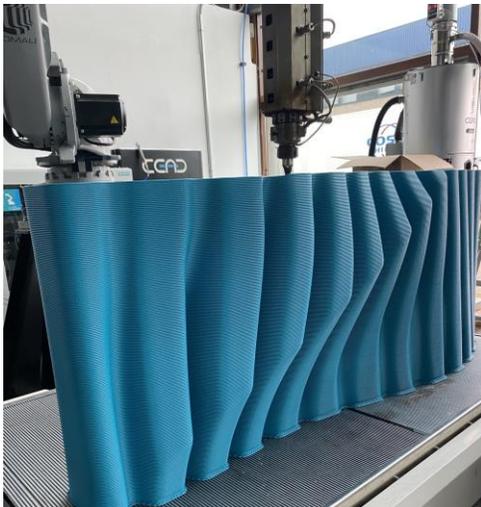


**The Performance Division in Europe** can provide a wide portfolio of **technical compound solutions**, maximising **sustainability experience** for all customers

# Examples of **circular feedstock** product portfolio



**Marvyflo™** is a range of PVC-based compounds applied in automotive interior surfaces (e.g. dashboard, door panel). All grades are now also available based on ISCC+ certified mass balance PVC resin. A new high-performance grade was developed, based on a 100% bio-based plasticiser. Combined with mass-balance PVC resin, more than 80% of fossil carbon is replaced with renewable carbon in this new grade.



**FGF recycled PIPG (post-industrial PET-G)** is a range of compounds based on post-industrial recycled PET-G and is applied for a diverse range of applications using the 3D printing technology of Large-Scale Additive Manufacturing.

# Examples of **circular feedstock** product portfolio



**TEFABLOC™ TG** is a range of Thermoplastic Elastomer compounds that contain a significant portion of renewable carbon. It is possible to incorporate a maximised content of 70% direct recycled materials (TGSIR02/R03), but specific products can also be fine-tuned for performance retention with the added benefit of using circular or biobased feedstock.

The ISCC+ certified Mass-Balance approach is possible as a means of further increasing the recycled content or complying with stringent regulations such as food contact approvals.



**VINIKA™ VG** is a range of PVC-based compounds with renewable carbon for the building industry and consumer applications. For rigid or soft PVC compounds, it is possible to combine the direct use of biobased materials with mass-balance derived PVC resins in order to achieve up to 90% renewable carbon.

# Examples of **circular feedstock** product portfolio



**Hostaphan® PCR** is a biaxially oriented polyester film with 30-70% PCR content. It is suitable for direct food contact and available in clear and white version. The siliconised version is used for liner and label applications.



**BioPBS™** (bio-based polybutylene succinate) is a bio-based and biodegradable polymer, developed based on advanced technology from Mitsubishi Chemical Corporation. Derived from natural resources, such as corn or sugarcane, BioPBS™ has been designed to be compostable in dedicated facilities into biomass, carbon dioxide and water, in respect to international standards and local policies.

# Circular Acrylic at Mitsubishi Chemical Methacrylate Europe



- The aim is to offer customers circular MMA and PMMA with the **same purity as virgin MMA and PMMA**.
- We will give our customers the option to use circular PMMA instead of traditional polymers. This will allow them to reduce their **Scope 3 greenhouse gas emissions**.
- The **design phase of product development** is crucial to ensure the circularity of acrylic products. In close cooperation with our value chain partners, we work to redesign their products in a way that embraces the circular nature of PMMA.
- We want to offer the market a **source for end-of-life PMMA** so it can be recycled back into circular MMA and PMMA.
- We are open to working with the whole **PMMA supply chain to develop reverse supply chains** that can increase the share of recycled post-industrial and post-consumer PMMA feedstock.



Lighthouse projects

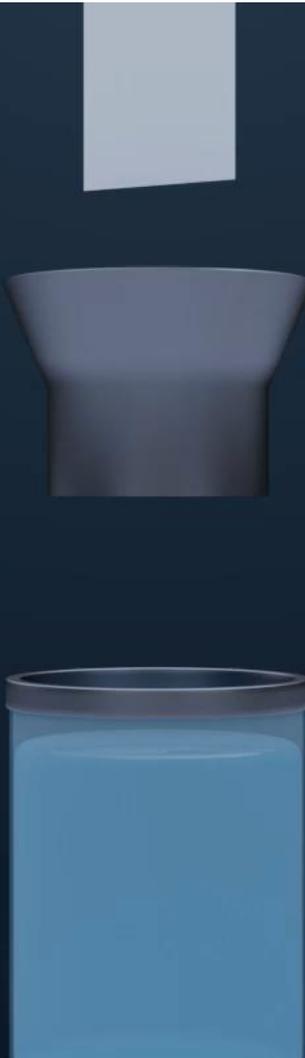
# Design for Circularity

# Nichigo G-Polymer – Design for Circularity

## Separation Technology

Mitsubishi Chemical has developed an innovative new polymer with unique properties.

The use of **Nichigo G-Polymer** enables the separation of multi-layer polymer films. This allows for recyclability of complex polymer products that cannot be recycled by conventional means.



## Ultra-high gas barrier packaging

G-Polymer can be used as a replacement of e.g. Aluminium or PVDC in multi-material laminates.

## Compostable barrier packaging

G-Polymer enables organic recycling as an alternative end-of-life treatment.

**Institute cyclos-HTP GmbH**  
Institute for recyclability  
and product sustainability



## Multilayer films contain our certified recyclable products: **SoarnoL™ EVOH Resins\*** & **Modic™ tie resin**

This has been confirmed by the Institute cyclos-HTP GmbH,  
an independent European test laboratory.

Follow the [link](#) to see the certificates

\* up to 15 weight %

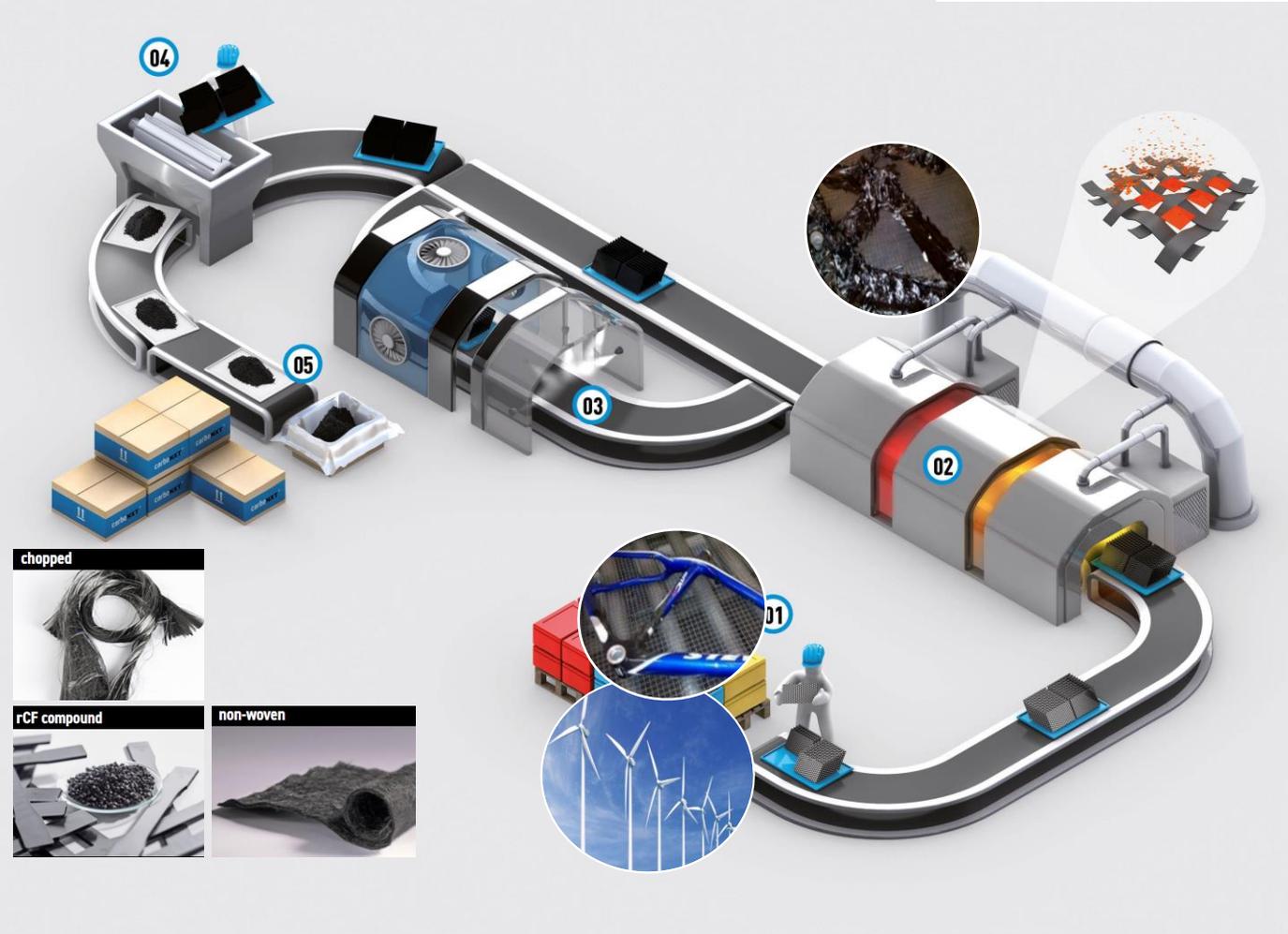
Lighthouse projects

**Close the loop**

# Close the loop - RECYCLING OF CARBON FIBRES



at **carboNXT**®



Mitsubishi Chemical group offers fabricators and OEMs a complete, industrialised **recycling process for carbon fibre materials**. This closes the loop from scrap collection to high-purity fibre creation for use in innovative, high-end applications.

The resulting products are made of **100% recycled carbon fibre (rCF)** and make a valuable contribution to the conservation of resources. The portfolio includes eight different product groups. The benefits of the recycled carbon fibres and products are:

- Long term supply security for rCF products
- Comparable high quality to virgin material
- Available in a variety of intermediates
- Better price - performance ratio
- reduced CO<sub>2</sub> equivalent

Follow the [Link](#) to see the explanation video

# Statera™ Overview

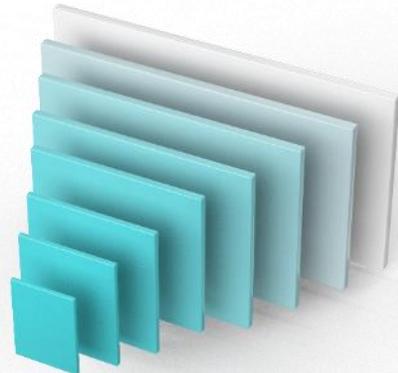


An exciting new offering to help future-proof your business by providing a seamless path to a more circular future.

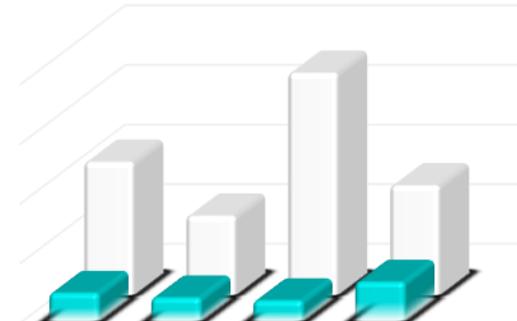
**Expertise** to minimize risks, speed up your transition and reduce your environmental footprint



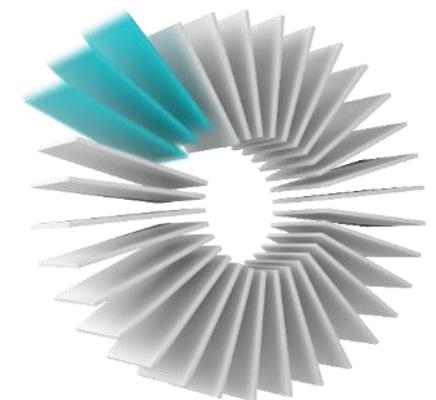
**Portfolio** of sustainable Sterra™ products with equivalent performance compared to virgin raw materials



Quantified environmental **footprint data** to use with your customers or reporting



Extensive waste and scrap **take-back program**



Lighthouse projects

**Extend the loop**

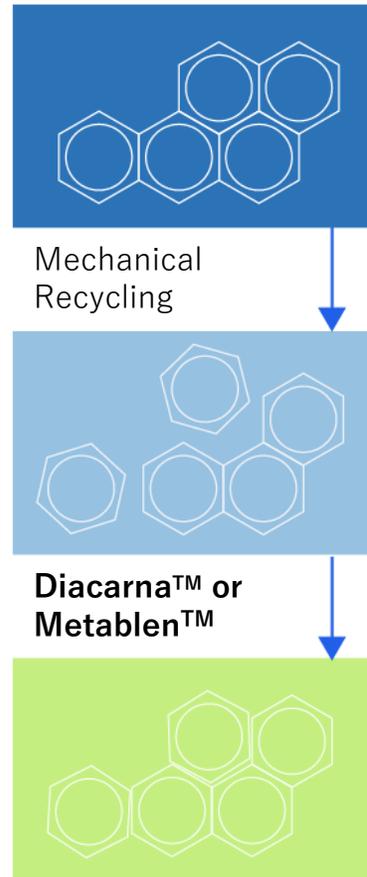
# Metablen™

## Impact modifier for recycling of plastics



Metablen™ is an acrylic based modifier which can be used for various kinds of plastics, e.g. ABS, POs, PC, PA to improve the mechanical properties of recycled plastics for different target industries.

By using Metablen™, the lifetime of plastics can be extended by improving their mechanical properties e.g. improved scratch resistance.



Polymers such as ABS, PO, PC, PA are recycled mechanically

Deterioration of the polymer backbone due to reduction of the molecular weight triggered by e.g. contamination, mixing or shear stress. Application of **Diacarna™ or Metablen™**

Improvement of mechanical properties by e.g. chain extension. Similar quality to virgin grades can be achieved

# Substantiating green claims



Mitsubishi Chemical Group in Europe is supporting the efforts of the European Green Deal to substantiate the environmental performance of our products against a standard methodology such as **Product Environmental Footprint (PEF)**.

When considering how to make a product more resource-efficient, the impact **over the whole life cycle of a product** should be taken into account in order to have a true understanding of its actual impact on the environment. From extraction of raw materials, production, use, reuse and waste management.



# Cooperations

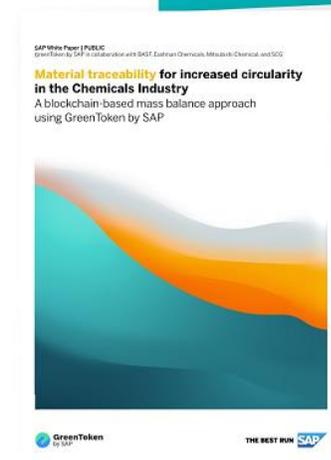
# Increasing transparency along the value chain with blockchain technology



Mitsubishi Chemical Europe together with BASF, SCG and Eastman Chemicals participated in a trial to use **SAP Green Token** blockchain technology to track and trace recycled chemical content along the value chain.

This white paper about material traceability was published in March 2022.

Follow the [Link](#) to see the full document.



## WHITE PAPER

### Material traceability for increased circularity in the Chemicals Industry

[Read Now](#)



# Circular Economy challenges for Start-ups



GROWTH GARAGE FROM MITSUBISHI  
CHEMICAL ADVANCED MATERIALS

## Growth garage accelerator

We're helping entrepreneurs and innovators get their engineering ideas from pitch to products in 3 months.



[Growth Garage Accelerator \(mcam.com\)](http://mcam.com)

# At Mitsubishi Chemical Group we believe in **cooperation**



Since 2010 Mitsubishi Chemical Group reports greenhouse gas emissions according to the Carbon Disclosure Project. In 2021 Mitsubishi Chemical group has received the highest rating in the CDP Water Security (A list).



In 2019, we became founding member of the Alliance to end plastic waste in the environment and protect the planet.

## World Economic Forum

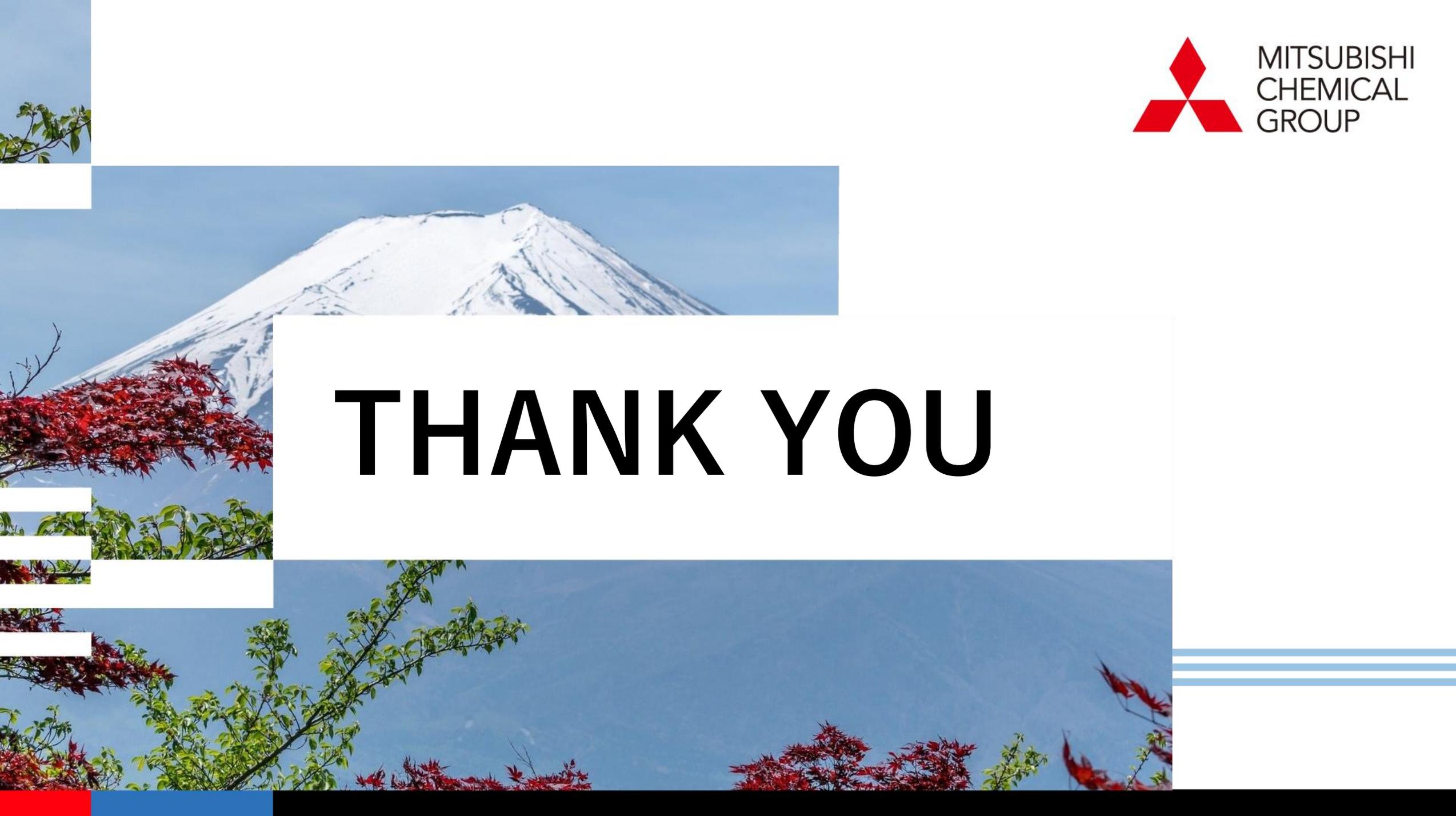
2019: member of the Low Carbon Emitting Technologies Initiative to accelerate the development and upscaling of low carbon emitting technologies for chemical production.



In 2020, we became the first Japanese company to join the value balancing alliance e.V. (VBA), an organisation established in June 2019 to create a global impact measurement and valuation standard for disclosing positive and negative impacts of corporate activity.



2021: Mitsubishi Chemical Holding has been selected for the fifth consecutive year as a member of the Dow Jones Sustainability Indices.



**THANK YOU**