

Safeguard the Environment

Circular Economy

PETRONAS' Circular Economy Definition

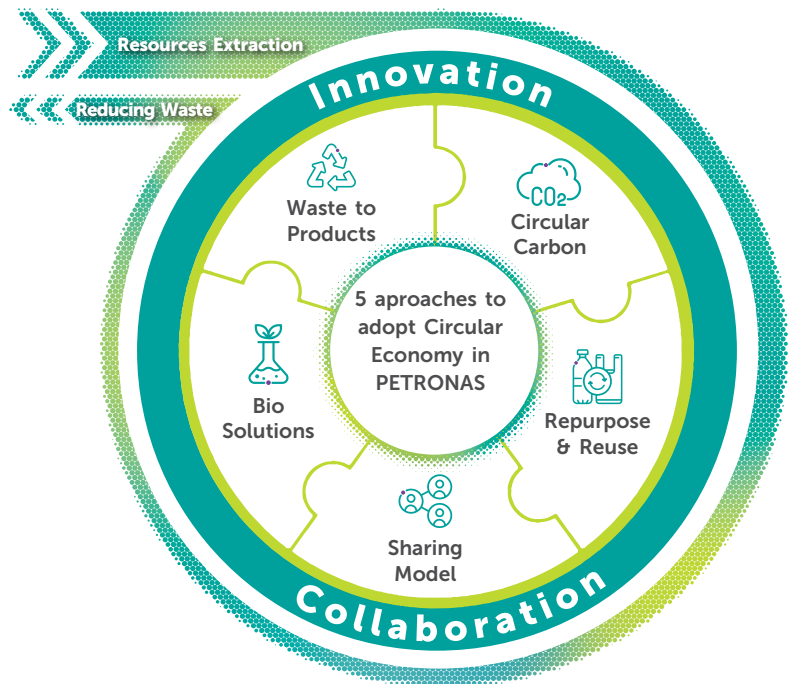
A circular economy is a systemic approach that moves away from a linear (take-make-waste) economy to one that extends the life cycle of materials and resources, ultimately reducing waste to a minimum.

For PETRONAS, circular economy is integral to our sustainability approach, embedded across the group to






- i. enable a low waste future
- ii. steward natural resources
- iii. minimise our carbon footprint

while creating value.

We aim to contribute to a circular future, providing impactful solutions to our stakeholders and the betterment of our society through innovation and collaboration.



Five Approaches to Adopt Circular Economy in PETRONAS

 Circular Carbon	 Sharing Model	 Bio Solutions	 Repurpose and Reuse	 Waste to Products
<p>Closed loop system involving 4Rs (reduce, reuse, recycle, remove) to manage GHG emissions</p> <p>Example: Condensate Recovery Systems (CRS)</p> <p>Capturing gas volumes that would have been 'wasted', channels it into the system, and converts the gas into condensate. This then flows through our usual processes, and is made into a valuable product.</p>	<p>Optimisation of resources via shared platform</p> <p>Example: Liquid8</p> <p>An online marketplace to encourage re-utilisation of surplus inventories, which would have otherwise been idle, accumulated and eventually become waste in warehouses – participated by Petroleum Arrangement Contractors (PACs) in Malaysia.</p>	<p>Bio-based inputs or products (regenerate)</p> <p>Example: Sustainable Aviation Fuel (SAF)</p> <p>A blend of SAF made from used cooking oil mixed with conventional jet fuel.</p>	<p>Extending useful life of materials/resources/facilities whether for their original or a new purpose to improve efficiency</p> <p>Example: Rig-to-Reef</p> <p>Cleaning platforms from hydrocarbons, removing non-reefable items, designing how it should be positioned (placement and stability analysis), which supports the growth of adjacent industries such as fishing and tourism.</p>	<p>Changing waste to base materials or other products, creating new revenue lines</p> <p>Example: Plastic Recycling</p> <p>Recycles plastic waste and uses it as feedstock for producing high-quality soft and hard plastics.</p>

Why Plastics?

Plastics have become a vital component in the economy given its usefulness in our everyday lives. It is a durable and lightweight material that has been used widely across industries worldwide. However, when it is used or disposed in an irresponsible manner, it becomes a significant problem as it is made of non-biodegradable material. Plastic waste is a significant part of the problem, and we are addressing it by promoting a circular economy and moving toward a New Plastics Economy (NPE). By recycling plastic products, we are minimising waste, promoting innovation, and creating new business opportunities. This supports a circular supply chain, reduces carbon footprint, conserves raw materials, and lessens the use of fossil fuels, all of which contribute to a more sustainable future.

We are addressing this by promoting circular economy and moving towards a NPE. By recycling plastic products, we are minimising waste, promoting innovation, and creating new business opportunities. We believe that our shift towards circularity will have a positive multiplier

effect, as we have in place a long value-chain that serves our ecosystem partners and broader society. Our ability to do this supports a circular supply chain, reduces carbon footprint and renders better stewardship of raw materials.

What Is Our Approach?

Through the circular economy approach, we have taken a waste-to-products approach, where we convert waste to base materials or other products to create sustainable value. However, we believe that the circular economy is not just about recycling and reusing but, instead, solving the problem at its source to eliminate waste and pollution. This will help us realise our NZCE 2050 Pathway.

We also continue to deepen our research and technology to identify gaps and accelerate our circular economy initiatives, as this will ensure sustainable consumption. Our ability to do so will lead to creating a more resilient economy.

Value Creation in 2022

1 PETRONAS' Positioning on Plastics

The increasingly harmful impact of plastic pollution on life and the environment is prompting regulations to crack down on plastic pollution, both globally and nationally, and has intensified in the last year alone, with industries facing the greatest risk and pressure to act. Plastic's wide range of applications includes medical, hospitality, construction/building, as well as fittings and furnishings. What makes plastics 'problematic' are single-use plastics (SUPs), such as plastic bottles, cutlery, and containers that are almost certainly littered. These are the primary sources of plastic pollution, with plastic bottles accounting for the greatest volume.

This year, we introduced PETRONAS' Position on Single-Use Plastics, which centres on our strategic focus on phasing out single-use plastics.

As we have a wide footprint across the plastics value chain, both as producers and consumers, this presents a wide range of opportunities for us to transition according to our circular economy principles and sustainability approach. Through this positioning, we acknowledge that plastics are still useful in industries such as food packaging, medical equipment, household appliances, etc. and recognise the need to take steps to strengthen their design and end-use sustainability. This will be done by phasing out problematic and unnecessary SUPs. In addition, we will also develop systemic plastic collection and recycling mechanisms at our operations to stop plastic waste from polluting or leaking into the

environment. This creates value by regenerating end-of-life plastic into valuable materials hence closing the loop in plastic circularity.

PETRONAS has a considerable footprint in the plastics value chain, both as a producer and a consumer, which means there are opportunities for us to transition according to our circular economy principles and our approach to sustainability. This enables PETRONAS to continue protecting value while also being a force for good.

PETRONAS Chemicals Group (PCG) leads the NPE initiative as it has embarked on Operation Clean Sweep (OCS), which is a global programme to eliminate plastic resin leakage to the environment during production and distribution.

In support of this, PETRONAS Lubricants International (PLI) launched the Bag-In-Box in Europe. This is a new 20-litre format made with recyclable cardboard and plastic, which guarantees loading, safety, and palletisation advantages, including an integrated tap.

Based on the recently launched Plastics Positioning, plastics will now be viewed as a force of good where we leverage circularity to encourage collaborative solutions that generate sustainable plastics, moving away from the traditional linear approach.

Safeguard the Environment

- PETRONAS Syntium Bag-In-Box (BIB) new **20-litre** format reduced plastic quantity up to **92 per cent** compared to traditional **20-litre** packs

PETRONAS' Four key New Plastics Economy (NPE) Workstreams

Innovation:
Establishing a viable collaboration in innovative technology solutions to address plastic pollution



Infrastructure:
Developing strategic partnerships and collaborations for an effective, sustainable waste recovery system



Education:
Imparting knowledge and education on plastic to address misconceptions and promote change in behaviour and culture



Clean-Up:
Enhancing awareness of caring for the environment through reduce, reuse and recycle (3R) education, Social Impact activities and green campaigns



PETRONAS Dagangan Bhd (PDB) redesigned their mineral water bottles to ensure they can be easily recycled. They have also discontinued retail sales of 350ml and 500ml bottles due to the non-optimal use of plastics.

2 Driving Plastics Circularity with ExxonMobil

PCG has joined forces with ExxonMobil to revolutionise the way plastic waste is managed, by transforming it into circular naphtha. As part of our commitment to sustainability, we are currently undertaking comprehensive feasibility studies to explore the potential implementation of ExxonMobil's advanced plastic waste recycling technology at suitable locations within PETRONAS production facilities.



3 Producing Waste-based Fuels

We participated in the Mid-Term Review of the 12th Malaysia Plan (RMK-12) – Technical Working Group (Oil and Gas and New Energy) Workshop by the Ministry of Economy. We presented a paper on the development of bio-economy in Malaysia, where we communicated our capabilities in leading Malaysia’s bio-economy industry as a part of Malaysia’s decarbonisation journey in achieving NZCE 2050. Through this presentation, we highlighted Malaysia’s capabilities in being a regional leader in producing waste-based biofuels, especially Sustainable Aviation Fuel (SAF), Hydrogenated Vegetable Oil (HVO) and other biofuel products via our first bio-refinery in Pengerang. This biorefinery aims to achieve Final Investment Decision (FID) in 2023 and be commissioned by 2026.

The establishment of this bio-refinery will create a bio-economy ecosystem in Malaysia, including the full value chain for feedstock sourcing and biochemicals. Once fully operational, this bio-refinery is expected to drive the local economy, generate more than 5,000 new jobs, benefit more than 1,000 SMEs and attract more than USD2 billion in green Foreign Direct Investment (FDI) into Malaysia.

4 Developing Plastic Modified Bitumen

We introduced our latest technology, Plastic Modified Bitumen (PMB), consisting of plastic waste mixed with bitumen. This mix of repurposed waste gives it extra strength and higher cohesiveness while reducing the maintenance lifecycle, making it a favourable material for infrastructure.

We tested these solutions at two separate locations, namely PETRONAS Research Sdn Bhd (PRSB) in September 2021 and at the Malaysian Federal roads, Jalan Simpang Pulau-Lojing-Blue Valley in December 2022.

Given the promising results, we will be collaborating with several government agencies in 2023. We will also be showcasing this technology to potential local and international partners.

- PMB will extend the lifecycle of pavement and roads by **25 per cent**.
- Every 100 metres with plastic-modified bitumen utilises a minimum of **79kg** of plastic waste.

5 Achieving a Circular Economy for Plastic Waste in Malaysia

Through PCG, we have set a target to recover 100 per cent of plastic waste equivalent to domestic polymer sales by 2030. To achieve this, we will focus on four key areas: innovation, infrastructure, education and clean-up. We are collaborating with various stakeholders, including waste management concessionaires, recyclers and technology providers, to create innovative solutions and enable a plastic circular ecosystem in Malaysia. This will enhance the recyclability of plastic materials and regenerate end-of-life plastic into valuable materials.

Under the innovation workstream, we collaborated with Plastic Energy Ltd to develop innovative solutions for plastic waste. This involves turning low quality, mixed plastic waste into pyrolysis oil, which can be further processed to produce certified circular polymers.

To strengthen the infrastructure system, we partnered with waste management companies; namely Alam Flora, KDEB Waste Management, One Biosys and E-Idaman to unlock the value of plastic waste ecosystem in Malaysia. Through these partnerships, we can ensure a secure supply of plastic waste, which is a crucial feedstock for converting plastic waste into circular polymers.