EXECUTIVE SUMMARY

NEW CLIMATE INSTITUTE

REGIONAL PRIORITIES FOR TACKLING PLASTIC LIFECYCLE IMPACTS

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Plastics are critical to global climate action. While public attention has focused on plastic pollution in oceans and rivers, the sector's climate impact is equally significant. **The plastics sector contributes between 3%[1] and 5%[2] of global greenhouse gas (GHG) emissions** – comparable to the aviation sector. This is especially concerning as plastics are one of the fastest-growing sources of industrial emissions, with production increasing from two million tonnes in 1950 to 400 million tonnes in 2022[3]. **Without intervention, emissions from plastics could more than double or almost triple by 2050[2],** consuming up to 31% of the remaining carbon budget from 2019 to limit warming to 1.5°C with a 67% chance[2].

Against this backdrop, this report provides a comprehensive analysis with three objectives: (1) mapping GHG emissions across the plastics value chain, (2) sequencing mitigation strategies to achieve a 1.5°C-aligned plastics sector and (3) assessing policies and actions in four major players with different circumstances on plastic production, consumption and trade (China, the European Union, Saudi Arabia, and the United States) to identify critical gaps and possible ways forward.

1
OECD (2022) doi: 10.1787/de747aef-en
2
https://energyanalysis.lbl.gov/publications/climate-impact-primary-plastic
3
Houssini et al. (2025) doi: 10.1038/s43247-025-02169-5

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PLASTICS AS A CAUSE OF CLIMATE CHANGE AND ENVIRONMENTAL POLLUTION

GHG emissions from plastics are a major driver of exacerbating climate change. The plastics lifecycle reveals a stark concentration of emissions in the **production phase, which accounts for 90% of total lifecycle emissions[1].** This results from energy-intensive processes – particularly steam cracking and methanol production – combined with the sector's reliance on fossil fuel as feedstock and energy input. Production emissions vary dramatically by route: the coal-based methanol-to-olefin (MTO) route has the highest emissions per tonne of plastic produced, followed by naphtha-based production using crude oil and ethane-based production using fossil gas. **End-of-life treatment contributes the remaining 10% of emissions,** primarily through incineration[1].

Plastics contribute significantly to ecosystem pollution, creating interconnected environmental crises. Approximately 30 million tonnes leaked into the environment in 2022[3], with ocean plastics projected to outweigh fish by 2050[4]. Microplastics have been found in almost every ecosystem and enter human bodies, causing health issues ranging from cognitive impairment to cancer[5].

The use phase critically influences both plastic production volumes and resulting waste flows. **Short-lived plastics** – such as single-use items – **are a major driver**, accounting for approximately 37%[1] of **global plastic production**. **Consumption patterns vary significantly across regions,** with per capita plastic use in high-income countries as high as 10 times that of lower income regions[1 3].

This twin crisis – climate change and pollution – demands integrated solutions.

PARIS-ALIGNED PATHWAY FOR THE PLASTICS SECTOR

The report sequences three mitigation strategies – minimising production, enhancing circularity and decarbonising production – to transform the plastics sector toward net-zero emissions **(see → Figure 1 for a schematic representation).** Sequencing is key to decarbonise plastics, starting with mature, short-term actions that can deliver immediate emissions cuts, while preparing for longer-term solutions. Priority is given to measures that also reduce environmental pollution and related health risks. This approach helps reduce cumulative emissions and avoids getting locked into unsustainable pathways. The sequencing is structured around three overarching goals: reducing the need for virgin plastics, producing necessary plastics without fossil feedstocks and powering the entire system with clean energy.

1
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https://energyanalysis.lbl.gov/publications/climate-impact-primary-plastic
3
Houssini et al. (2025) doi: 10.1038/s43247-025-02169-5
4
The New Plastics Economy: Rethinking the future of plastics
5
Symeonides et al. (2021) doi: 10.1111/jpc.15777

STRATEGY 1: MINIMISE PRODUCTION

This strategy aims to reduce overall plastic production and consumption by eliminating plastic uses that do not require replacement and substituting plastics with alternative materials. Reduction of plastic production and consumption offers a low-cost and low-emissions pathway to cutting fossil fuel dependence and can be achieved through the elimination of unnecessary plastics or material efficiency[6]. Its implementation faces behavioural lock-in challenges – particularly in high-income countries, where plastic use is deeply embedded in daily life and often perceived as a cheap and convenient option[7]. The environmental benefits of substitution by alternatives to plastics depend on several context-specific factors, including the weight, durability, end-of-life treatment and production footprint of the alternatives[8 9]. Beyond emissions reductions, this strategy also plays a critical role in addressing plastic waste, helping to curb environmental pollution and mitigate associated health risks.

STRATEGY 2: ENHANCE CIRCULARITY

Maximising recycling reduces virgin feedstock demand through two primary routes. Mechanical recycling, the most mature option, can achieve 75-90% emission reductions versus virgin production[10] but currently only represents less than 10% of global plastic production[1]. The quality of waste streams and physical limitations of the process – products can only be recycled a concrete number of times – limits the amount of plastic that can be recycled through mechanical processes[11]. **Chemical recycling** can handle contaminated waste streams that mechanical recycling cannot process, but it risks diversion to fuel production rather than maintaining plastic-to-plastic circularity and is an energy- and emission-intensive process[12]. Both approaches face the fundamental limitation that recycling capacity cannot match projected demand growth, reinforcing the essential role that production and demand reduction strategies play[13]. At the same time, this strategy is also critical to reduce environmental pollution and the associated health risks.

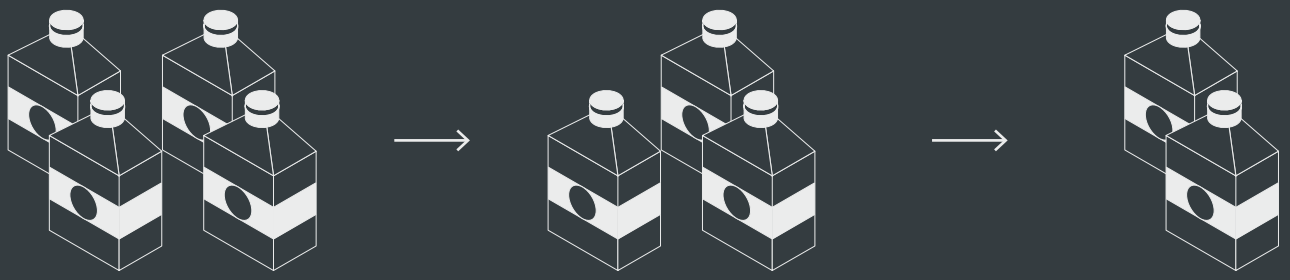
STRATEGY 3: DECARBONISE PRODUCTION

For essential remaining production, reducing the use of fossil fuel as feedstock and as an energy source is essential to reduce emissions intensity. Alternative feedstocks, whether bio-based or synthetic, face significant constraints – biomass competes with food systems[14] and other sectors decarbonisation needs[10], while synthetic routes combining carbon capture and use (CCU) with green hydrogen remain at early technology readiness level (TRL 3)[12]. Carbon capture and storage (CCS) cannot achieve 100% capture rates and risks perpetuating fossil fuel dependence[12]. Processes can be powered with the use of clean energy sources such as green hydrogen, but this requires massive renewable expansion and the implementation of electrolysers at the required scale[6]. Electrification through electric steam crackers could eliminate combustion emissions but still faces process emissions and infrastructure challenges[12]. Decarbonising remaining production over the coming decades will require a combination of these different technologies[15 16].

1
OECD (2022) doi: 10.1787/de747aef-en
6
ReShaping Plastics | SYSTEMIQ
7
Tilsted et al. (2023) doi: 10.1016/j.oneear.2023.05.018
8
Dolci et al. (2024) doi: 10.1177/0734242X241241606
9
Meng et al. (2024) doi: 10.1021/acs.est.3c05191
10
IEA (2023) doi: 10.1787/fd522f59-en
11
Mission Possible: Reaching Net-Zero Carbon Emissions - ETC
12
IPCC (2022) doi: 10.1017/9781009157926
13
Aligning the Global Plastics Treaty with <1.5oC
14
ETC/WMGE Report 3/2021: Greenhouse gas emissions and natural capital implications of plastics (including biobased plastics) — Eionet Portal
15
Meys et al. (2021) doi: 10.1126/science.abg9853
16
Stegmann et al. (2022) doi: 10.1038/s41586-022-05422-5

ES Figure 1:
Sequencing process of mitigation options for plastics decarbonisation

How can we reduce the need for virgin plastic?



Reduction of plastic production and consumption
Eliminate unnecessary plastics and reduce material intensity

Substitution by alternatives to plastics
Substitute plastic products with environmentally sound options

Enhance recycling
Keep plastic materials in a closed cycle

How can we produce necessary plastics without fossil feedstock?

Bio-based and synthetic feedstocks
Use bio or synthetic feedstock to replace fossil-based plastic

Fossil feedstocks with CCUS
For unavoidable fossil use, apply CCUS to mitigate emissions during production

How can we power production cleanly?

Electrification of production
Electrification of steam cracking and other low-temperature production processes

Clean energy sources
Green H_2 to power high-temperature processes

RISKS AND CHALLENGES OF PLASTICS DECARBONISATION: ACTIONS NEEDED TO CHANGE COURSE

Limited development and deployment of some of the key mitigation technologies pose significant risks. There is a growing risk of over-reliance on unproven technologies – such as carbon capture, utilisation, and storage (CCUS) and green hydrogen – being treated as "silver bullet" solutions, assuming future availability and scalability of these technologies. This could lead to fossil fuel lock-ins and delay necessary action today. Similarly, other technologies not yet widely available at scale, such as bio-based feedstock and chemical recycling, may pose trade-offs by shifting environmental burdens to new domains.

As the full decarbonisation of plastics requires the strategic combination of these technologies, it is **essential to prioritise research, development, demonstration and deployment (RDD&D) to accelerate their maturity and availability.** However, this must be accompanied by a **precautionary approach, recognising the risks and challenges these technologies face.** Accordingly, the report proposes a sequencing of mature short-term actions with less mature long-term solutions. This approach enables immediate emissions reductions, minimising cumulative emissions and avoiding lock-in or unsustainable decarbonisation pathways.

POLICIES AND MEASURES IN SELECTED MAJOR ECONOMIES WITH DIFFERENT NATIONAL CIRCUMSTANCES

The report analyses China, the European Union (EU), Saudi Arabia, and the United States (US) because they collectively dominate global plastics across all dimensions – fossil extraction, feedstock production, manufacturing, consumption and trade. Each represents a distinct production route and faces unique challenges.

ES Table 1:

Characteristics of the four selected major economies related to plastic lifecycles, with classification based on global comparisons

	China	EU	Saudi Arabia	US
Plastic production [by volume]	Largest producer	Third largest producer	Outside top 10	Second largest producer
Production system	Coal – based/ MTO	Crude oil – based/ Naphtha	Fossil gas – based/ Ethane	Fossil gas – based/ Ethane
Plastic use	Largest consumer by volume	Second largest per capita consumer	Outside top 10	Largest per capita consumer
Trade	Largest importer of refined products* Largest exporter of plastic products**	Important role as importer and exporter in every category	Second largest exporter of refined products*	Largest exporter of refined products*
Key importance	Largest consumer and producer of plastic products**	Declining producer and high per capita consumer	Large producer of refined products* for other regions	Large producer and highest per capita consumer

*Fossil fuel outputs of the refining process of crude oil and fossil gas that are used as basic building blocks in the production of plastics.

** Final plastic product, ready to be used.

Many countries have introduced regulations targeting plastic pollution[17], primarily aimed at reducing environmental leakage. Strategy 1: minimise production and strategy 2: enhance circularity are covered by nearly all the four countries and regions analysed, although they predominantly apply these strategies to tackle plastic pollution. Most advanced frameworks include production reduction targets and bans on specific plastic categories, such as China's Plastic Pollution Control Action Plan[18] and the EU's Single-Use Plastic Directive[19] targeting limited production reduction goals by banning specific plastic categories. Circularity is promoted through a range of instruments and incentives – such as the EU's Packaging and Packaging Waste Regulation[20], which aims to enhance reusability and recyclability. However, policies covering these two strategies often fall short due to limited scope (e.g. only addressing limited plastic types), vague targets and insufficient focus on systemic and behavioural change.

Across nations, there are a disproportionately small number of climate-related policies that explicitly address plastics[21], and policies on reducing emissions from industrial energy use have historically also been sparse[22]. The four countries selected here are no exception. Strategy 3: decarbonising production lacks specific plans for the plastic industry and depend on broader frameworks designed for industry or industrial sectors – such as chemicals. Some of the policies and targets analysed may even increase emissions. For example, China's Clean and Efficient Use of Coal[23] promotes coal use in the chemical industry and Saudi Arabia's Vision 2030[24] encourages growth in gas-based sectors like plastic production. Specificity is essential, and decarbonisation policies targeting plastics are needed.

17
The plastics landscape: regulations, policies and influencers | Engagement guide | PRI
18
国家发展改革委 生态环境部关于印发"十四五"塑料污染治理行动方案的通知_国务院部门文件_中国政府网
19
Directive - 2019/904 - EN - SUP Directive - EUR-Lex
20
Regulation - EU - 2025/40 - EN - EUR-Lex
21
https://www.iea.org/policies/ (accessed 31 July 2025). Only 36 out of more than 11,000 policies in the database mentioned 'plastic'
22
Nascimento et al. (2021) doi:10.1080/14693062.2021.1993776
23
【关于加强煤炭清洁高效利用的意见(发改运行〔2024〕1345号)】-国家发展和改革委员会
24
National Industrial Development and Logistics Program

WAY FORWARD

Immediate action is needed to reduce plastic production and demand through reduction of plastic production and consumption, substitution by alternatives to plastics with environmentally sound options and enhanced circularity. **Full decarbonisation of the plastic sector requires industrial transformation** of the current production systems.

TAILOR DECARBONISATION PATHWAYS TO NATIONAL AND REGIONAL CONTEXTS

Countries dominating global plastic production and consumption are also among the world's major economies. These regions **possess the economic and technological capacity to lead decarbonisation of the plastics sector** through domestic policy, global cooperation and investment in RDD&D for emerging technologies. Moreover, financial support to other regions should be lead primarily from these regions to support global decarbonisation of the sector.

Strategy 1: Minimise production

Decarbonising plastics requires distributed and coordinated leadership ensuring consumption and production systems are addressed globally. To implement an ambitious phase-out of unnecessary plastics and reduce overall plastic use, **countries with high per capita consumption must take the lead, driving systemic changes in how plastics are consumed and perceived in their countries.** At the same time, **regions with lower per capita consumption must avoid building unnecessary dependencies on plastics** as their economies and populations grow.

Alternative materials to plastics, need to be addressed through regionally appropriate strategies, ensuring sustainable use and avoiding resource over-exploitation.

Strategy 2: Enhance circularity

Recycling must be enhanced globally, with countries that have already advanced recycling infrastructure supporting processing of waste streams from regions with limited access to these technologies and transferring the required technology. **Export of waste to third countries lacking adequate processing capacity must stop,** since top exporters are among the richest countries in the world and have the means to process their own waste domestically.

Strategy 3: Decarbonise production

Major producing countries must decarbonise their production systems. Those with **upcoming infrastructure renovation needs have a unique opportunity** to align new investments with clean technologies. Countries with **newer assets must adapt their systems to enable retrofitting** with cleaner feedstocks and cleaner energy. **Fossil-dependent countries must explore new strategic roles** in a decarbonised plastic future, leveraging their specific advantages to support the transition of the sector. Countries **decarbonisation plans must avoid overreliance on single-technology solutions** – especially on technologies that are currently under development or not ready at scale – given the risks they pose to achieving emissions reduction targets.

STRENGTHEN INTERNATIONAL COOPERATION

Plastics are part of an interconnected global system, and addressing their impacts requires international coordination that extends beyond national borders. **The International Legally Binding Instrument (ILBI) on plastic pollution provides an opportunity to establish common targets for reducing production and scaling up circularity.** At the same time, **alignment with the UNFCCC is essential:** plastics must feature prominently in national decarbonisation plans, including Nationally Determined Contributions (NDCs) and long-term low-emissions development strategies (LT-LEDS). Only through such international cooperation will it be possible to address both emissions and pollution from plastics and ensure that the sector contributes to keeping global temperature rise within 1.5°C.

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