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THE PLASTIC WASTE MAKERS INDEX

Revealing the source of the single-use plastics crisis

MINDEROO FOUNDATION

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ACKNOWLEDGEMENTS

Minderoo Foundation

Minderoo Foundation is proudly Australian, and one of Asia Pacific's largest philanthropic organisations, with AU$2 billion committed to a range of global initiatives.

The Plastic Waste Makers Index is a project of Minderoo's No Plastic Waste initiative, which aims to create a world without plastic pollution – a truly circular plastics economy, where fossil fuels are no longer used to produce plastics. A critical step towards this goal is to bring greater transparency to the plastics supply chain – to better understand its material and financial flows, its environmental impacts, the commitments its companies have made to sustainability, and the effectiveness of government policies.

This report offers an unprecedented glimpse into the small number of petrochemicals companies, and their financial backers, generating almost all single-use plastic waste globally. We hope that this data will inform better decision-making – by industry, policy-makers, investors and the public.

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Cover Image:
Plastic waste pollution which leads to environmental problems. Photo credit: zeljkosantrac via Getty Images.

Analytical partners

Neural Alpha is a sustainable fintech start-up solving the biggest challenges in sustainability and finance using innovative, connected data technologies. For this report, it supported the analysis of customs data to track single-use plastic material flows.

Planet Tracker is a non-profit financial think tank aligning capital markets with planetary boundaries. For this report, it supported the analysis of equity ownership of polymer producers.

Profundo is an independent not-for-profit company which aims to make a practical contribution to a sustainable world and social justice with profound and fact-based research and advice. For this report, it supported the analysis of financing of polymer producers.

Wood Mackenzie is an energy research consultancy that empowers strategic decision-making in global natural resources with quality data, analysis and advice. For this report, it supported the analyses of single-use plastics material flows and of capacity expansion for polymer production.

Limited assurance

Minderoo Foundation engaged KPMG to perform a limited assurance engagement with respect to its preparation of the "Results in detail" as presented in this report, in accordance with the Plastic Waste Makers Index: Basis of Preparation (which can be found at www.minderoo.org/plastic-waste-makers-index/findings/methodology/). KPMG's primary deliverable for the engagement was a limited assurance report that is available at www.minderoo.org/plastic-waste-makers-index/downloads/. The engagement was performed in accordance with Australian Standard on Assurance Engagements ASAE 3000 *Assurance Engagements Other than Audits or Reviews of Historical Financial Information* issued by the AUASB.

As part of the engagement, KPMG performed procedures to test that the calculation methodology is appropriately described in the Basis of Preparation, that the data sourced and key assumptions used in the methodology were clearly identified and supported by source documentation, and the calculations were performed with mathematical accuracy and in accordance with the methodology. Given the pioneering nature of the analysis, KPMG has not assured the methodology itself, only the accuracy of its application.

KPMG does not undertake any responsibility arising in any way from reliance placed by a third party on their report.

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Acknowledgements

We also thank our colleagues Matt Bolt, Simon Clarke, Niki Comparti, Fiona David, Shaun Devitt, Margot Dons, Anthony Flannery, Alyssa Lane, Fabien Laurier, and David Ohana for their valuable contributions and support.

We would like to thank Martin Stuchtey and the team at SYSTEMIQ Ltd. for their collaboration and analytical support across our transparency initiative.

Disclaimer

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To quote this paper, please use the following reference:
Charles D, Kimman L, & Saran N 2021, *The Plastic Waste Makers Index*, Minderoo Foundation.

Digital resources

Visit www.plasticwastemakersindex.org to explore the data behind this report

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FOREWORD

Former Vice President, United States of America Al Gore

The trajectories of the climate crisis and the plastic waste crisis are strikingly similar – and increasingly intertwined. For generations, we've treated our atmosphere like an open sewer, constantly pumping massive amounts of greenhouse gas emissions into the air each day. Similarly, we are treating the ocean like a liquid landfill left to accumulate at least eight million metric tons of plastic waste each year.

Scientists, environmentalists, and watchdogs sounded the alarm on the climate crisis for decades, providing ever-more detailed data on its causes and eventual impacts. Fossil fuel polluters tried to obscure the catastrophic damage and existential risk they were causing and tried to evade responsibility for their contribution to the problem – but eventually the data caught up with them.

Two of the biggest markets for fossil fuel companies – electricity generation and transportation – are undergoing rapid decarbonization, and it is no coincidence that fossil fuel companies are now scrambling to massively expand their third market – petrochemicals – three-quarters of which is the production of plastic. They see it as a potential life raft to help them stay afloat, and they're telling investors that there's lots of money to be made in ramping up the amount of plastic in the world. Since most plastic is made from oil and gas – especially fracked gas – the production and consumption of plastic are becoming a significant driver of the climate crisis, already producing greenhouse gas emissions on the same scale as a large country and causing the emission of other harmful toxins from plastics facilities into nearby communities – disproportionately harming people of color and those in low-income neighborhoods. Moreover, the plastic waste that results – particularly from single-use plastics – is piling up in landfills, along roadsides, and in rivers that carry vast amounts into the ocean.

That's why the *Plastic Waste Makers Index*, prepared by the Minderoo Foundation and its partners, comes at such a critical time. As awareness of the toll of plastic pollution has grown, the petrochemical industry has told us it's our own fault and has directed attention toward behavior change from end-users of these products – rather than addressing the problem at its source!

But with comprehensive new data and analysis on the producers, funders, and enablers of our global plastic addiction, this groundbreaking analysis gives us the tools we need to limit plastic waste pollution and measure our progress. While the scale of the problem can seem overwhelming, this report shows that fewer than 100 companies are the ultimate source of these harmful products.

Tracing the root causes of the plastic waste crisis empowers us to help solve it. Just as disclosure of greenhouse gas emissions was the first step towards creating global targets for reductions, disclosure of funding for and production of single-use plastic is necessary to turn the tide on this escalating problem. With the *Plastic Waste Makers Index* as an essential baseline, policy-makers, industry and financial services companies can craft the steps necessary to move us toward a sustainable future.

Former Vice President Al Gore is the cofounder and chairman of Generation Investment Management, and the founder and chairman of The Climate Reality Project, a nonprofit devoted to solving the climate crisis.

Plastic waste washed up on a beach in the Dominican Republic. Photo credit: Dustan Woodhouse via Unsplash.

THE COST OF SINGLE-USE PLAST ENORI

Trash island in the Caribbean.
Photo credit: Caroline Power

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EXECUTIVE SUMMARY

Collection of blue plastic bottles pressed ready for recycling. Photo credit: Kemter via Getty Images

Single-use plastics – the cheap plastic goods we use once and then throw away – epitomise the plastics crisis. Today, single-use plastics account for over a third of plastics produced every year, with 98 per cent manufactured from fossil fuels.

Unsurprisingly, single-use plastics also account for the majority of plastic thrown away the world over: more than 130 million metric tons in 2019 – almost all of which is burned, buried in landfill, or discarded directly into the environment.

The cost of single-use plastic waste is enormous. Of all the plastics, they are the most likely to end up in our ocean, where they account for almost all visible pollution, in the range of five to 13 million metric tons each year.[1,2,3] Once there, single-use plastics eventually break down into tiny particles that impact wildlife health – and the ocean's ability to store carbon.[4] Single-use plastics contain chemical additives such as plasticisers that have been found in humans and are linked to a range of reproductive health problems.[5] And if growth in single-use plastic production continues at current rates, they could account for five to 10 per cent of the world's greenhouse gas emissions by 2050.[6]

Despite these threats, the plastics industry has been allowed to operate with minimal regulation and transparency for decades. Government policies, where they exist, tend to focus on the vast number of companies that sell finished plastic products. Relatively little attention has been paid to the smaller number of businesses at the base of the supply chain that make "polymers" – the building blocks of all plastics – almost exclusively from fossil fuels.

These companies are the source of the single-use plastic crisis: their production of new "virgin" polymers from oil, gas and coal feedstocks perpetuates the take-make-waste dynamic of the plastics economy. The economies of scale for fossil-fuel-based production are undermining transition to a "circular" plastic economy, with negative impacts on waste collection rates, on end-of-life management and on rates of plastic pollution. The focus needs to be on producing recycled polymers from plastic waste, on re-use model and on alternative substitute materials.

Part of the problem is that we can't manage what we can't measure. In this report, we identify for the first time the companies that produce from fossil fuels the five primary polymers that generate the vast majority of single-use plastic waste globally ("virgin single-use plastic polymer producers") – and which investors and banks are funding them. We also assess which companies are making real efforts to create a circular plastics economy, and estimate how virgin polymer production is expected to grow or decline in the future.

THE FIVE MAJOR FINDINGS OF OUR REPORT ARE:

1

In 2019, just 20 polymer producers accounted for more than half of all single-use plastic waste generated globally – and the top 100 accounted for 90 per cent.

ExxonMobil and Dow – both based in the USA – top the list, followed by China-based Sinopec, with these three companies together accounting for 16 per cent of global single-use plastic waste. Of approximately 300 polymer producers operating globally, a small fraction hold the fate of the world's plastic crisis in their hands: their choice, to continue to produce virgin polymers rather than recycled polymers, will have massive repercussions on how much waste is collected, managed and leaks into the environment.

2

Major global investors and banks are enabling the single-use plastics crisis.

Twenty institutional asset managers – led by US companies Vanguard Group, BlackRock and Capital Group – hold over US$300 billion worth of shares in the parent companies of these polymer producers, of which an estimated US$10 billion comes from the production of virgin polymers for single-use plastics. Twenty of the world's largest banks, including Barclays, HSBC and Bank of America, are estimated to have lent almost US$30 billion for the production of these polymers since 2011.

3

There has been a collective industry failure to transition away from fossil-fuel-based feedstocks.

The 100 largest polymer producers all continue to rely almost exclusively on "virgin" (fossil-fuel-based) feedstocks. In 2019, production of recycled polymers from plastic waste – a "circular" model – accounted for no more than two per cent of total output. Over 50 of these companies received an "E" grade – the lowest possible – when assessed for circularity, indicating a complete lack of policies, commitments or targets. A further 26 companies, including ExxonMobil and Taiwan's Formosa Plastics Corporation, received a "D-" due to their lack of clear targets/timelines.

4

Planned expansion of virgin polymer production capacity threatens to overwhelm hopes of a circular plastics economy.

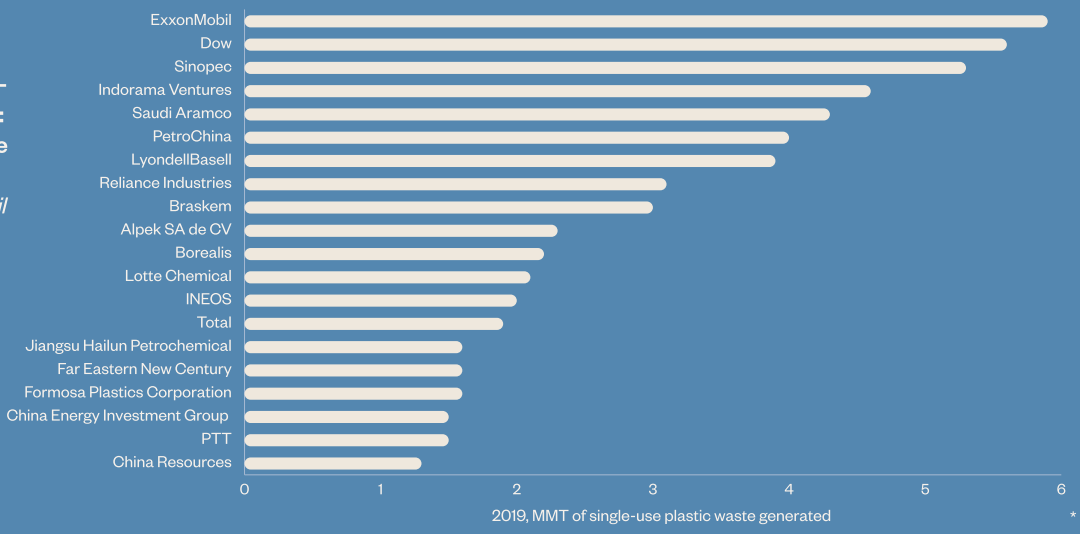
In the next five years, global capacity to produce virgin polymers for single-use plastics could grow by over 30 per cent – and by as much as 400 per cent for individual companies. An environmental catastrophe beckons: much of the resulting single-use plastic waste will end up as pollution in developing countries with poor waste management systems. The projected rate of growth in the supply of these virgin polymers is in line with the historical rate of growth in demand for single-use plastics – which will likely keep new, circular models of production and re-use "out of the money" without regulatory stimulus.

5

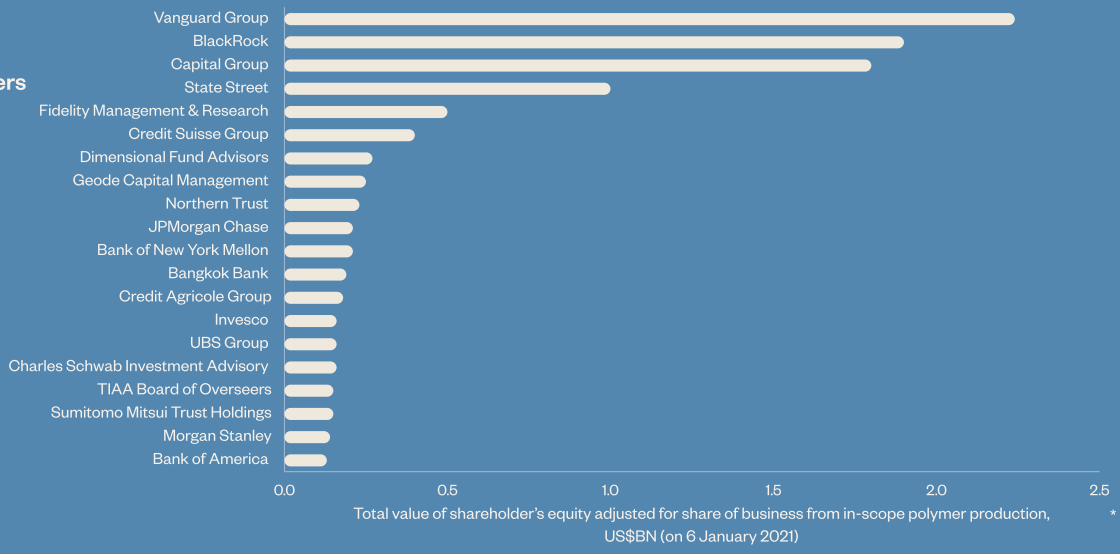
Single-use plastic waste is an entrenched geopolitical problem.

Transitioning away from the take-make-waste model of single-use plastics will take more than corporate leadership and "enlightened" capital markets: it will require immense political will. This is underscored by the high degree of state ownership in these polymer producers – an estimated 30 per cent of the sector, by value, is state-owned, with Saudi Arabia, China, and the United Arab Emirates the top three. In addition, it will likely require concerted action on the international political stage to resolve deep-rooted regional imbalances and inequities. High income countries are typically supplying low and lower-middle income countries with significant volumes of polymer; and while this latter group of countries generates far less single-use plastic waste per person, the reverse is true in terms of mismanaged waste and plastic pollution.

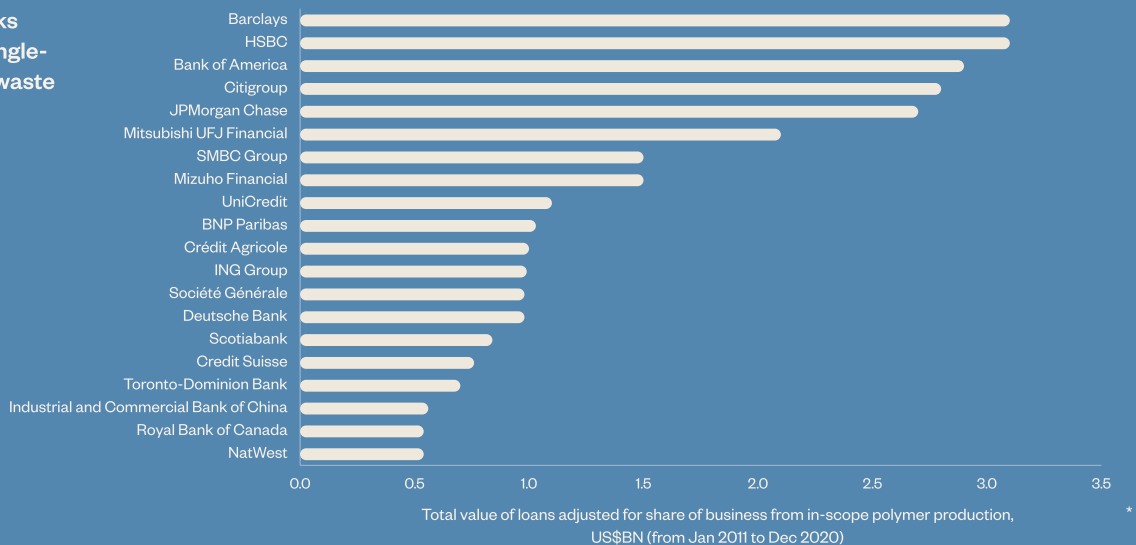
Top 20 polymer producers generating single-use plastic waste: The Plastic Waste Makers Index.
See results in detail for the top 100.



Top 20 institutional asset managers investing in single-use plastic waste



Top 20 banks financing single-use plastic waste



*Data covered by KPMG assurance

Recommendations

This report has major implications for the main stakeholders in the single-use plastics crisis:

- **Polymer producers**
- **Investors and banks**
- **Policy-makers**
- **Other companies in the supply chain**

POLYMER PRODUCERS

Polymer producers represent an extraordinary leverage opportunity in the fight against plastic pollution, as the "gatekeepers" of plastic production – particularly because they are relatively few in number. As policy-makers and investors recognise this fact, the disruptions and risks facing these companies will only grow. Polymer producers wishing to maintain a competitive advantage should:

- **Disclose levels of virgin versus recycled polymer production and their associated single-use plastic waste "footprint".** The estimates presented here are only as good as our data. Polymer producers should use our methodology to estimate – and then disclose – their contribution to single-use plastic waste as a material business risk.
- **Quit paying lip service to sustainability and seize the opportunity to re-tool.**
  Set real, quantifiable and time-bound commitments to reduce reliance on fossil fuel feedstocks and shift to circular recycled polymers.
- **Commit to using circularity measurement and reporting tools.**
  One example is the *Circulytics* initiative from the Ellen MacArthur Foundation, which supports a company's transition towards the circular economy, and reveals the extent to which a company has achieved circularity across its entire operations.[7]

INVESTORS AND BANKS

Institutional asset managers and global banks are providing billions of dollars to companies that produce polymers from fossil fuels – as much as 100 times more than they provide to companies trying to shift to a circular economy. This asymmetry urgently needs to be reversed. Investors and banks should:

- **Disclose the level of lending and investment in virgin versus recycled polymer production and the associated generation of single-use plastic waste.**
  Shareholders and customers have a right to know if their money is being invested or lent to entities whose products have negative impacts on people and the planet – a measure of single-use plastic waste must be included in annual environmental, social and governance reporting.
- **Commit to funding a circular plastics economy.**
  Adopt policies and targets that shift capital away from virgin polymer production and towards companies using recycled plastic waste as feedstock. Phase out entirely investing in and financing new virgin single-use plastic capacity.
- **Use measures of circularity to inform capital allocation decisions and shareholder action.** Active fund managers should be using circularity as a screening criteria for investments in polymer producers. Passive fund managers can use the same tools to take action at shareholder meetings and exert influence over boards and management. Banks should link lending to circular business outcomes.

POLICY-MAKERS

Solving the single-use plastic problem will take more than the actions of progressive polymer producers or the influence of capital markets. It will also require policy-makers to display great political will and practical action. Policymakers should:

- **Target policies at polymer producers.**
  With the knowledge of which companies are at the source of the single-use plastic waste crisis, policy-makers can now draft effective regulatory responses, such as policies that require recycled polymer production from plastic waste feedstocks, and therefore incentivise greater waste collection; or economic incentives that accelerate the transition from virgin to recycled polymers, such as a levy on virgin production.
- **Accelerate a global treaty on plastic pollution.**
  A Montreal Protocol or Paris Agreement-style treaty may be the only way to bring an end to plastic pollution worldwide. The treaty must address the problem at its source, with targets for the phasing out of fossil-fuel-based polymers and encouraging the development of a circular plastics economy.
- **Require full disclosure from producers and users of single-use plastics in order to better monitor the supply chain.**
  Insist on "single-use plastic footprint" being a mandatory reporting metric – as per the equivalents that are rapidly becoming mandatory in carbon accounting.[8]

OTHER COMPANIES IN THE SUPPLY CHAIN

While not the focus of the analyses in this report, other companies in the single-use plastics supply chain share responsibility for ensuring the promise of a circular plastic economy becomes a reality. Converters of plastic polymers, packaged goods brands, and retailers should:

- **Convert voluntary commitments to use more recycled single-use plastics into firm market signals.**
  Long-term forward contracts for recycled polymers and products will create the stability needed for investment in recycling infrastructure. Contracts should also account for the full cost of collecting, sorting and recycling waste, and accept the price premium over virgin polymer and plastics.
- **Design for recyclability.**
  Users of plastic have a responsibility to ensure their products are easy to recycle. This means phasing out many hard-to-recycle multi-material single-use plastics, as well as the use of problematic performance – or appearance-enhancing additives. Creating common standards for recycled material quality, specifications and authentication will also improve the efficiency of waste management and recycling systems.
- **Reducing unnecessary single-use plastics.**
  This is perhaps the most significant means to reduce single-use plastic waste in the short-term. Opportunities include: re-designing packaging and single-use products to use lower volumes of plastic; scaling innovative re-use models; and using substitute materials.

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Most of the top producers own facilities in multiple countries and trade internationally – contributing to plastic pollution globally. Photo credit: zorazhuang via Getty Images.

INTRODUCTION

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Plastic trash and garbage underwater off Cebu Island, Philippines. Photo credit: Brent Durand via Getty Images.

Many single-use plastics – face masks, medical equipment, shopping bags, coffee cups and cling film – are everyday "essentials" in our lives. They prolong both our lives and the shelf-life of the consumer economy, and their rise has been nothing short of phenomenal – with production doubling since 2005 alone, and expected to increase by a further third between 2020 and 2025. Today, they are the most common type of plastic produced, consuming over a third of all polymers – the building blocks of plastics – made every year.

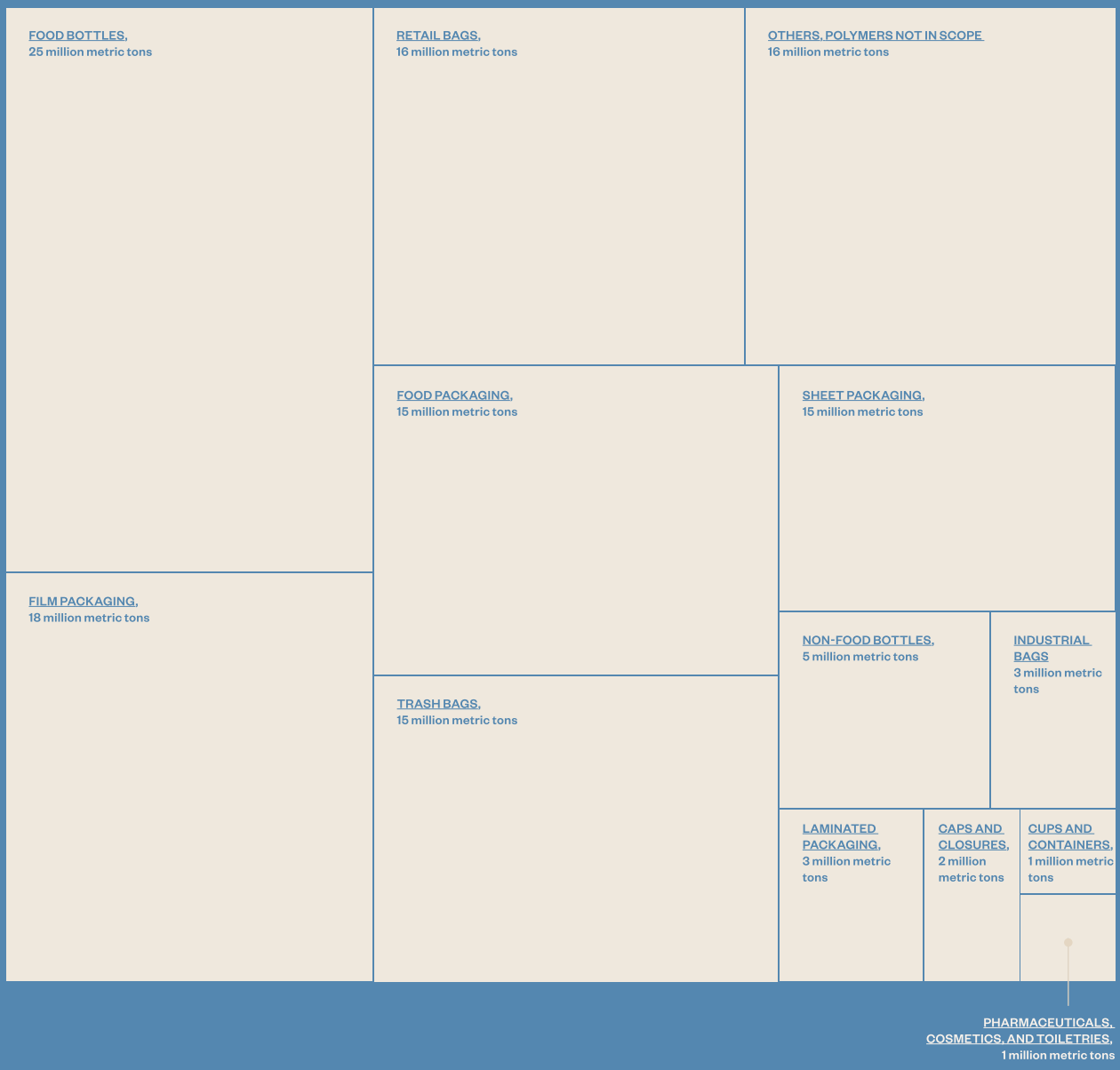
But there's a catch. Single-use plastics are also the hardest plastics to collect, sort and recycle: global recycling rates have been stuck at just 10 to 15 per cent for over thirty years. In fact, we estimate that over 130 million metric tons of single-use plastics were thrown away in 2019 (Figure 1) – of which roughly 35 per cent were burned, 31 per cent buried in managed landfills, and 19 per cent dumped directly on land or into the ocean as pollution.[9]

Single-use plastics are also a growing source of greenhouse gas emissions. Some 98 per cent are produced from fossil fuel, or "virgin" feedstock.[10] If current trends in plastic production and use continue, emissions from single-use plastics are likely to triple, accounting for five to 10 per cent of global greenhouse gas emissions by 2050.[11] Many oil and gas companies are planning to "ride out" decarbonisation in the transport and energy sectors by redirecting fossil fuels into plastics.

Human health impacts are beginning to be understood and are emerging as a major threat. Single-use plastics break down into microplastics which have then been found in cancers.[12] Much smaller nanoplastics also form, but reliable measurement techniques are urgently needed to see whether they cross barriers into organs and cells, as well as breach the blood-brain barrier.[13] Single-use plastics contain chemical additives such as plasticisers that have been found in humans and are linked to a range of reproductive health issues. And when plastic waste is burned in an uncontrolled manner – for heat or fuel, for example – as roughly half of all burned plastic is, it poses a risk to vulnerable communities in developing countries.[14,15]

Figure 1

Single-use plastic product categories, million metric tons, 2019



Consumption of many single-use plastics has increased during the Covid-19 pandemic – with plastic pollution likely to have worsened as a result. An aerial photo of floating plastic and styrofoam trash polluting a corner of Siak River, Pekanbaru in Indonesia. Photo credit: Afrianto Silalahi/Barcroft Media via Getty Images.

What is driving the single-use plastic waste crisis?

Four factors are at play:

1. **Relentless product proliferation:**
   Use of single-use plastics has increased exponentially over the last 30 years, driven by innovation of new packaging formats and single-use plastic products, resulting in substantial levels of unnecessary plastics.
2. **Cheap fossil fuel feedstocks:**
   It continues to be far cheaper to produce single-use plastics from fossil fuels than from "green" feedstocks, i.e., recycled plastic waste. Consider the cost of door-to-door collecting, sorting and recycling of household plastic waste versus the economies of scale enjoyed by virgin polymer producers with ready access to fossil fuels via purpose-built pipelines. As a result, the single-use plastics we throw away have little to no value because there is no demand for them. And without a commercial incentive to collect waste, collection rates are largely dependent on the availability of public funding.
3. **Lax regulation:**
   The costs of waste management and plastic pollution are escalating globally, yet single-use plastic producers, brands and retailers remain financially "off the hook". Many policy-makers have started to experiment with producer pays policies, which hold companies that produce and use plastic products accountable for their disposal – but few of these schemes exist in developing countries, where they are most needed.[16]
4. **Widespread mismanagement of single-use plastic waste:**
   In high income countries, waste management infrastructure has mostly proved sufficiently mature and well-funded to deal with the accelerating accumulation of single-use plastic waste, mainly by burying or burning it – although the growth in exports of plastic waste from the EU, USA and Japan (particularly prior to China's ban on imports from 2016) is an indicator of a system reaching its limits. In low and lower middle income countries, where the required infrastructure is often absent and underfunded, single-use plastic consumption is creating an environmental disaster.[17]

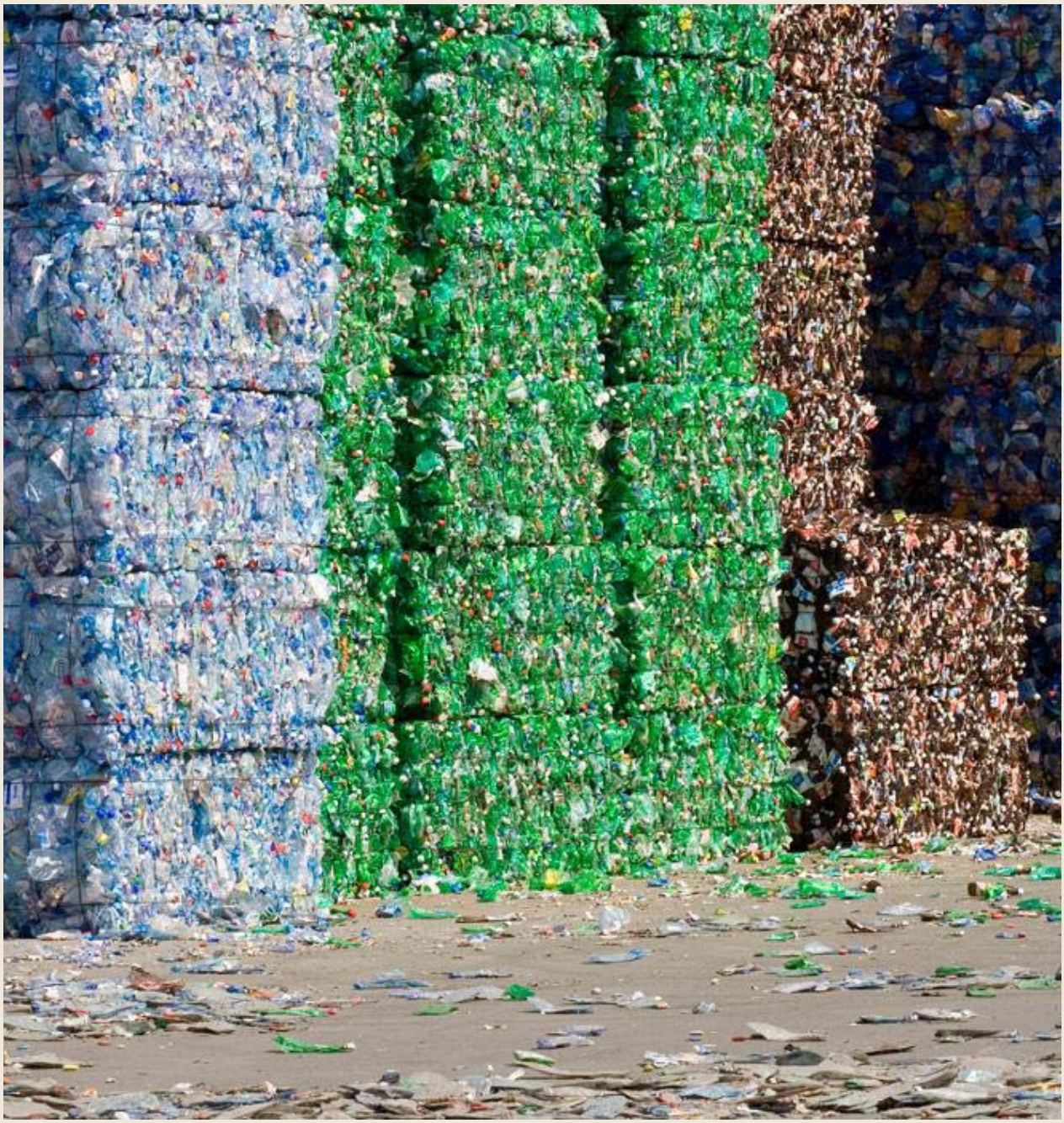
The solution

Solving the single-use plastic crisis is the shared responsibility of both businesses and policy-makers. It will require halting growth in demand for single-use plastics (e.g., reducing unnecessary plastics like single-use straws and bags); designing products to be reused or recycled; and properly funding waste management systems. The solutions will need to include and improve the working conditions of the millions of people who already play a pivotal role in the economy, informally collecting and trading plastic waste in developing countries. And they will also need to consider the greenhouse emissions of single-use plastics across their life-cycle, and mitigate contributions to climate change – e.g., by switching to sustainable bio-based feedstocks.

At the root of the problem are the companies that continue to produce new polymers made from fossil fuels. Industry needs to transition from this linear model of production to a circular model: where recycled polymer production stimulates functioning commodity markets for single-use plastic waste; where there is a strong commercial incentive to collect all the plastics we throw away; and where, ultimately, we eliminate plastic pollution.

The purpose of this first report is to shine a light on these poorly-regulated companies, and trace the route by which they generate the world's single-use plastic waste. The companies that control this "tap" of new plastics production are the source of the problem – and must become part of the solution. This effort is intended to serve as a bridge to industry and an invitation to collaborate on future editions. We call on them to support the urgent need for radical transparency and the transition to a circular plastics economy.

Solving the single-use plastic crisis is the shared responsibility of both businesses and policy-makers.



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The purpose of this report is to trace the route by which polymer production generates the world's single-use plastic waste. Photo credit: Meinrad Riedo via Getty Images.

OUR APPROACH

Shredded bits of polypropene plastic. Most single-use plastics end up as mixed waste with little to no commodity value. Photo credit: Santiago Urquijo via Getty Images.

Who produces the polymers forming single-use plastics and how much ends up as waste?

To answer this question we built a model of global single-use plastic material flows from polymer production to waste generation.

Our analysis included only virgin polymers given they accounted for more than 98 per cent of all production in 2019, our baseline year for data. In future editions, we expect to include recycled and bio-based polymers as production of these increases in scale.

First, we identified approximately 1,200 production facilities globally that produce the five main polymers that account for almost 90 per cent of all single-use plastics: polypropylene (PP); high-density polyethylene (HDPE); low-density polyethylene (LDPE); linear low-density polyethylene (LLDPE); and polyethylene terephthalate (PET). We then estimated the volume of plastic polymer produced in 2019 at each facility (Step 1; Figure 2). These facilities are owned and operated by approximately 300 distinct companies. Both the facilities and the production estimates were provided by Wood Mackenzie, an energy research consultancy.

We then tracked how the polymers leaving each facility were traded globally using data from UN Comtrade as well as over 500,000 customs bills of lading – a document that accompanies all shipped goods (Step 2). Within each country of destination, we also modelled what proportion of polymers were converted into single-use plastics versus non-single-use products, based on installed capacity of different conversion processors (e.g., sheet extrusion and roto-moulding), using data provided by Wood Mackenzie (Step 3).

Finally, we estimated the volume of single-use plastics traded in bulk (i.e., raw packaging materials) (Step 4), and within finished/packaged goods themselves (Step 5) – and simulated those trade flows through to the consumption and disposal stage. We used both UN Comtrade and World Bank data for these steps. This results in an estimate of every polymer producer's contribution to single-use plastic waste in every country (Step 6).

We emphasise that our analysis ends at the generation of single-use plastic waste. With few exceptions, there is currently an absence of reported data on the material flows of single-use plastics after they have been discarded and become waste – whether they go to landfill, are burned, or enter the ocean as pollution. This means that, for now, our analysis is unable to quantify the link between polymer producers and plastic pollution.

Figure 2

Our six-step approach to linking polymer producers to single-use plastic waste generation.

	STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6
MATERIAL FLOW	Polymer production	Polymer trade	Polymer conversion	Trade in single-use plastics in bulk	Trade of single-use plastics in finished goods	Single-use plastics MSW*
KEY QUESTIONS	Who produces polymers that form single-use plastic, where and how much?	What are the trading patterns between polymer producers and countries?	How are polymers converted into single-use plastic product categories?	How are the relevant categories of bulk packaging traded?	What mass of single-use plastic in finished goods is traded and what are the trade patterns?	What is the mass of single-use plastic in municipal solid waste (MSW) and what is its source?
KEY DATA SOURCE	**Wood Mackenzie**	**Export Genius** **UN Comtrade**	**Wood Mackenzie** **American Chemistry Council**	**UN Comtrade**	**McKinsey Global Institute** **World Bank World International Trade Solution**	**Result of this analysis**
IN-SCOPE MASS, million metric tons	~200	~90	~110	~40	~25	~110

**MSW stands for Municipal Solid Waste.*

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Major global investors and banks are enabling single-use plastics production and pollution. Photo credit: d3sign via Getty Images.

Who funds these polymer producers and is effectively enabling the single-use plastic waste crisis?

SHAREHOLDERS

To identify who owns the polymer producers identified above, we sourced shareholder data for public companies from Bloomberg and for private companies from Orbis. We classified shareholders into three classes: institutional asset managers (e.g., pension funds, mutual funds, insurance companies), state owners, and private individuals or institutions.

Next, we estimated the value of the shareholders' equity. In almost all cases, production of polymers used for single-use plastics represents only part of a company's activities. We wanted to estimate only the value attributable to single-use plastic polymer production – versus other diversified businesses not directly related to generating single-use plastic waste – and therefore adjusted the total value of the equity accordingly.

We omitted bond holdings from the analysis due to looser regulatory requirements to report bond ownership, which make identification of bondholders more challenging.

BANKS

Banks play a crucial role in the financing of single-use plastic polymer production plants. Credit provided in the form of short-and long-term loans provides working capital and expansion capital, ensuring that plants are both constructed and operational. Underwriting share and bond issuances is also a vital support provided by banks, offering access to capital markets and guarantees that deals will be successful.

To identify which banks are providing loans and underwriting facilities, we sourced data on the banking sector's financing of the top 50 polymer producers over a 10-year timeline, from January 2011 to December 2020, from Bloomberg, Refinitiv and IJGlobal. To estimate the financing specifically attributable to single-use plastic production, we adjusted the total value of financing accordingly.

Who are the leaders and laggards in the move to circularity?

To gauge how much progress the top polymer producers have made towards sustainability, we used a set of indicators of circular business practices – adapted from Ellen MacArthur Foundation's *Circulytics* survey – to develop a ratings framework (A-E, with E being the lowest score) and assessed the performance of the top 100 companies based on data in their public reports.[18]

Indicators included: the percentage of polymer output that comes from recycled plastic waste or bio-based feedstocks; the percentage of products that are recycled; inclusion of circularity in corporate strategy and targets; and engagement with suppliers and customers to create sustainable supply chains.

What is the near-term outlook for production of single-use plastics from virgin polymers?

Finally, we estimated growth in virgin polymer production globally by 2025, based on data provided by Wood Mackenzie on expected growth in single-use plastic polymer capacity at an asset level. Only projects that were currently operational and/or deemed likely to occur were included.

For a detailed method regarding any of the above, see Method in detail.

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Close to 85 per cent of all single-use plastics is produced from just five polymers - PP, PET, LLDPE, HDPE and LDPE. Shown here is the manufacture of plastic bags which are commonly made from LDPE. Photo credit: firemanYU via Getty Images.

OUR INSIGHTS

INSIGHT 1

Just 20 polymers producers accounted for more than half of all single-use plastic waste generated globally in 2019.

The single-use plastics crisis can be linked to a relatively small number of companies, with 20 polymer producers accounting for an estimated 55 per cent of waste globally – and the top 100 accounting for over 90 per cent. Two integrated oil and gas companies, US-based ExxonMobil and China-owned Sinopec, rank first and third, respectively, with the largest chemicals company in the world, US-based Dow, at number two. Together, we estimate these three companies alone generate around 16 per cent of global single-use plastic waste.

Eleven of the top 20 polymer producers are based in Asia (five in China), with a further four in Europe, three in North America, one in Latin America, and one in the Middle East. Most of the producers own facilities in multiple countries and all trade internationally, thus contributing to plastic waste (and pollution) globally.

Four of the top 20 companies produce exclusively PET, a polymer which is mainly used to make bottles and other rigid plastics (Figure 3). These companies likely generate less plastic pollution than their peers, as rigid plastics have higher rates of collection and recycling than lower-value, flexible plastics.

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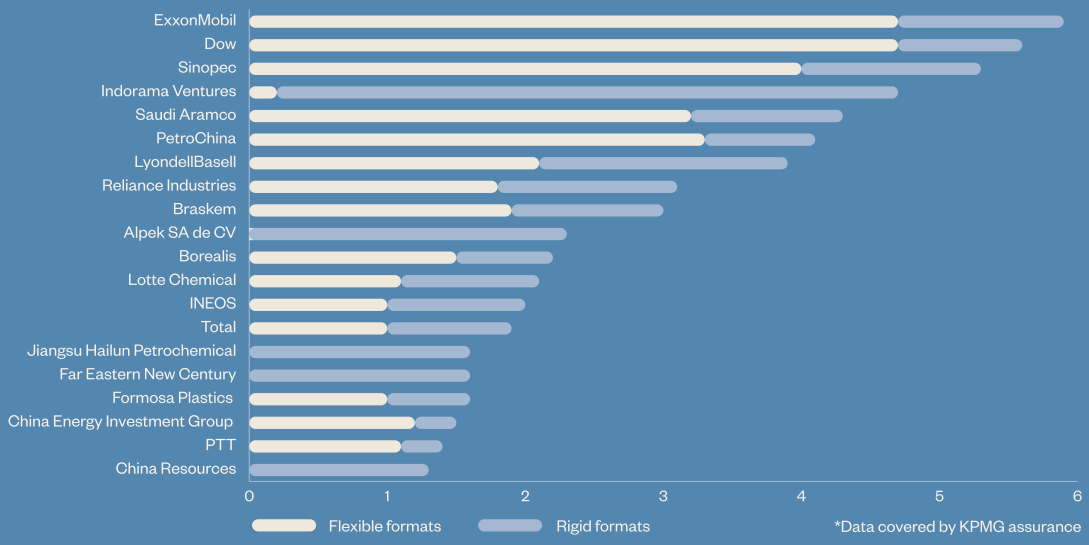
Sites like this petrochemical plant, capable of producing 150,000 metric tons of plastic polymer per year, are found all over the world. Photo credit: Bim via Getty Images.

Figure 3

Top 20 polymer producers generating single-use plastic waste, 2019, million metric tons



Implications

- Of approximately 300 single-use plastic polymer producers operating globally, a small fraction hold the fate of the world's plastic crisis in their hands: their choice, to continue to produce virgin polymers rather than recycled polymers, will have massive repercussions on how much waste is collected, managed and leaks into the environment.
- Today, regulation is largely aimed at the tens of thousands of companies that sell finished goods using single-use plastics. A more effective solution would be to tackle the waste plastic crisis via the polymer producers at the base of the supply chain, which are relatively few in number. Improvements at this stage would cascade through the supply chain, with a disproportionate impact on circularity and plastic pollution.
- Given the clear link between virgin polymer production and the escalating single-use plastic crisis, it is incumbent on companies at the base of the supply chain to disclose their contribution to the problem – to publish their single-use plastic "footprints" as part of their material business risk analysis.
- We have produced a methodology that allows polymer producers to estimate the amount of single-use plastic waste they account for – but the calculation is only as good as the data. The next step is for the entire industry to commit to full data transparency. Assuming a groundswell in policies that ban, tax, or extract levies to pay for the costs of single-use plastics, companies that take the lead in this space will ultimately be rewarded.

INSIGHT 2

Major global investors and banks are enabling the single-use plastic crisis.

Twenty institutional asset managers hold shares worth almost US$300 billion in the parent companies of the polymer producers identified – of which we estimate US$10 billion is invested in production of the virgin polymers that generate almost all single use plastic waste globally. Since 2011, we estimate that 20 of the world's largest banks lent more than US$30 billion for the production of these polymers. The actions of just a few funders could exert significant influence on the single-use plastic waste problem.

Investors

The top three investors are US-based. Vanguard, BlackRock, and Capital Group, have an estimated US$6 billion invested in single use plastic waste generation, through shareholdings worth over US$150 billion in the parent companies of these polymer producers (Figure 4).

While Vanguard and BlackRock's investments are mainly held passive funds, which are designed to mirror the performance of stock market indices (e.g., S&P500), Capital Group's investments are actively managed, i.e., the fund manager selects specific stocks looking for the best returns.

Passive fund managers will need to rely on corporate governance oversight and voting power to pressure companies to reduce their role in single-use plastic waste generation. Active fund managers, in contrast, can screen out specific stocks based on sustainability criteria. Actions taken by these three US investment giants will resonate across the whole plastics industry.

Banks

More than 500 banks lent an estimated US$50 billion for production of virgin polymers between 2011 and 2020, and underwrote bond and equity issuances worth more than US$30 billion over the same 10-year period. Our analysis also shows that more than half of the financing of this polymer production is provided by just 20 major banks.

UK-based Barclays tops the list, despite being ranked 18th globally in terms of assets,[19] suggesting that it has a disproportionate business exposure to single-use plastic waste generation (Figure 5). Barclays has provided a large amount of loans to both private (Borealis, INEOS) and public (LyondellBasell, ExxonMobil) polymer producers. UK-based HSBC also ranks in the top five.

Three of the top five banks on the list are US-based – JPMorgan Chase, Citibank and Bank of America – as are US investment banks Goldman Sachs and Morgan Stanley. Together with their importance as investors, our analysis suggests that the US is an important source of funding for the single-use plastic crisis. Remaining banks on the top 20 list are based in Europe (8), Japan (3), Canada (1) and Thailand (1).

We note that the estimated value of loans provided by banks is significantly larger than the value of institutional asset manager investments. This is largely due to the fact that banks lend to both publicly-listed and private companies, unlike institutional investors, which only fund the former: collectively, privately-controlled polymer producers currently generate more single-use plastic waste than publicly-listed ones.

Figure 4

Top 20 institutional asset managers investing in single-use plastic polymer producers. Total value of shareholder's equity adjusted for share of business from in-scope polymer production, US$BN (on 6 January 2021)

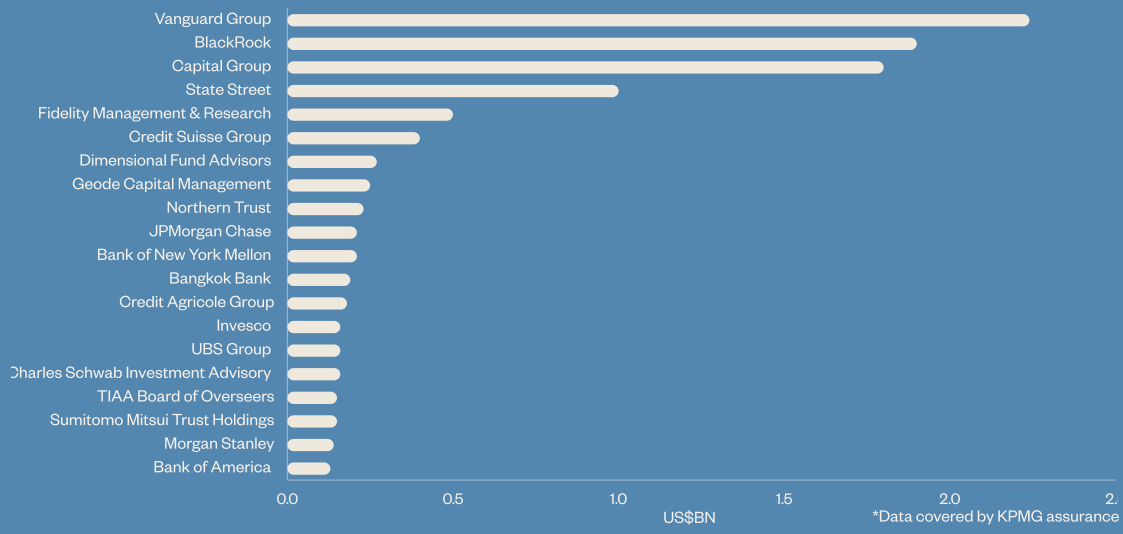
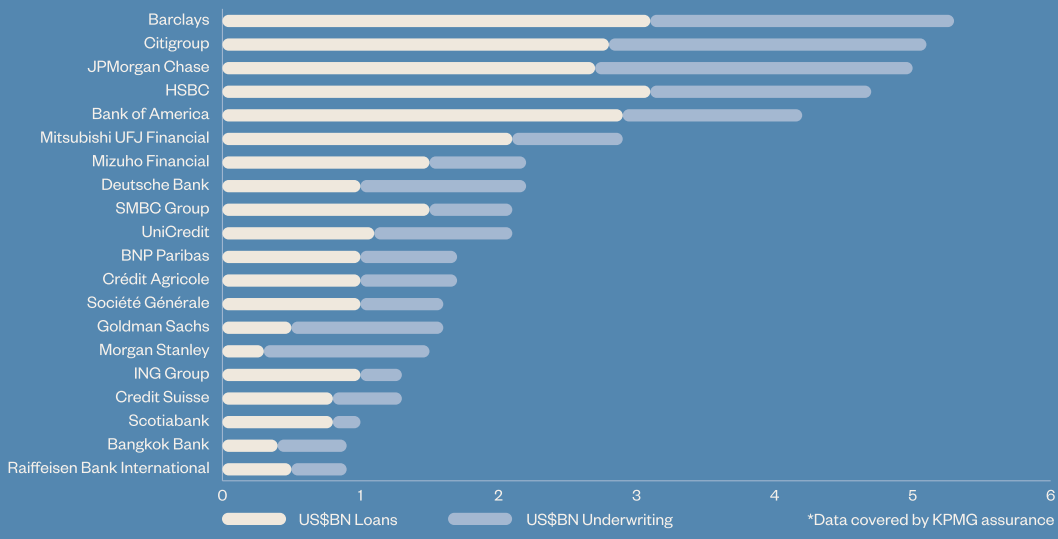


Figure 5

Top 20 banks providing lending to and underwriting equity and bond issuances for single-use plastic polymer production. Total value of loans and underwriting adjusted for share of business from in-scope polymer production, Jan 2011 to Dec 2020 (US$BN)



Implications

Financial institutions must enable the circular plastics economy rather than accelerate the environmental catastrophe of plastic waste. To remain competitive, as regulatory and consumer behaviour continues to shift in many regions of the world, investors and banks should:

- Calculate their exposure to single-use plastic waste – using the methodology presented here, for example – and disclose it.
- Include targets to radically reduce investment and/or financing of single-use plastic waste in their environmental, social and governance policies.
- Phase out or stop altogether investments in and/or financing of new virgin plastic production capacity.

The employees of these institutions should also generate internal debates to reflect on their institution's contribution to plastic waste, asking themselves how they can use their strong influence as employees to help the bank or asset manager become a better institution and eliminate plastic waste-making.

Financial institutions that fail to make this transition successfully and continue to invest in fossil-fuel-based polymer producers face numerous risks:

- **Financial**
  Potential for lower returns on investment as progressive regulation impacts industry revenue growth (e.g., bans on single-use plastic products); extended producer responsibility schemes lead to increased costs; and capital expenditure in new virgin polymer production results in over-capacity. For banks, there is risk of "stranded" assets and defaults on loans.
- **Reputational**
  Growing shareholder, regulatory and societal expectations to move capital away from public companies with poor environmental, social and governance records. Clients have a right to see how their money is being invested and a right to choose for it not to be invested in enabling plastic pollution, but this is only possible if exposure to plastic is part of screening criteria and this information is disclosed.
- **Legal**
  Fiduciary duties to manage risk appropriately; statutory duties to incorporate environmental, social and governance considerations into capital allocations decisions; and various disclosure obligations regarding the environmental impacts of specific financial products and institutions as a whole.

INSIGHT 3

There has been a collective industry failure to transition away from fossil-fuel-based feedstocks.

Our analysis shows that polymer producers remain almost exclusively reliant on virgin feedstocks: not a single company among the largest 100 polymer producers procures more than two per cent of its feedstock from recycled or bio-based materials. These overwhelmingly disappointing results demonstrate that the industry is barely at the start of its journey to circularity.

Fifty-four companies received an "E" grade for circularity – the lowest grade possible – including four of the top 20 polymer producers: Saudi Aramco, PetroChina, China Energy Investment Group and Jiangsu Hailun Petrochemical. These 54 companies have made zero progress towards circularity, i.e., they lack any policies, commitments or targets to replace fossil fuel feedstocks with sustainable alternatives (Figure 6).

A further 26 companies, including ExxonMobil and Taiwan's Formosa Plastics Corporation, received a "D-" grade. This means that while there may be some policies or commitments to reduce fossil-fuel derived plastics, there are no clear targets or timelines – no evidence that the company has actioned the commitments.

Some of the top 100 polymer producers have large-scale projects underway to increase their use of recycled feedstocks, which are taken into account by the analysis (see case study on pages 38-39).

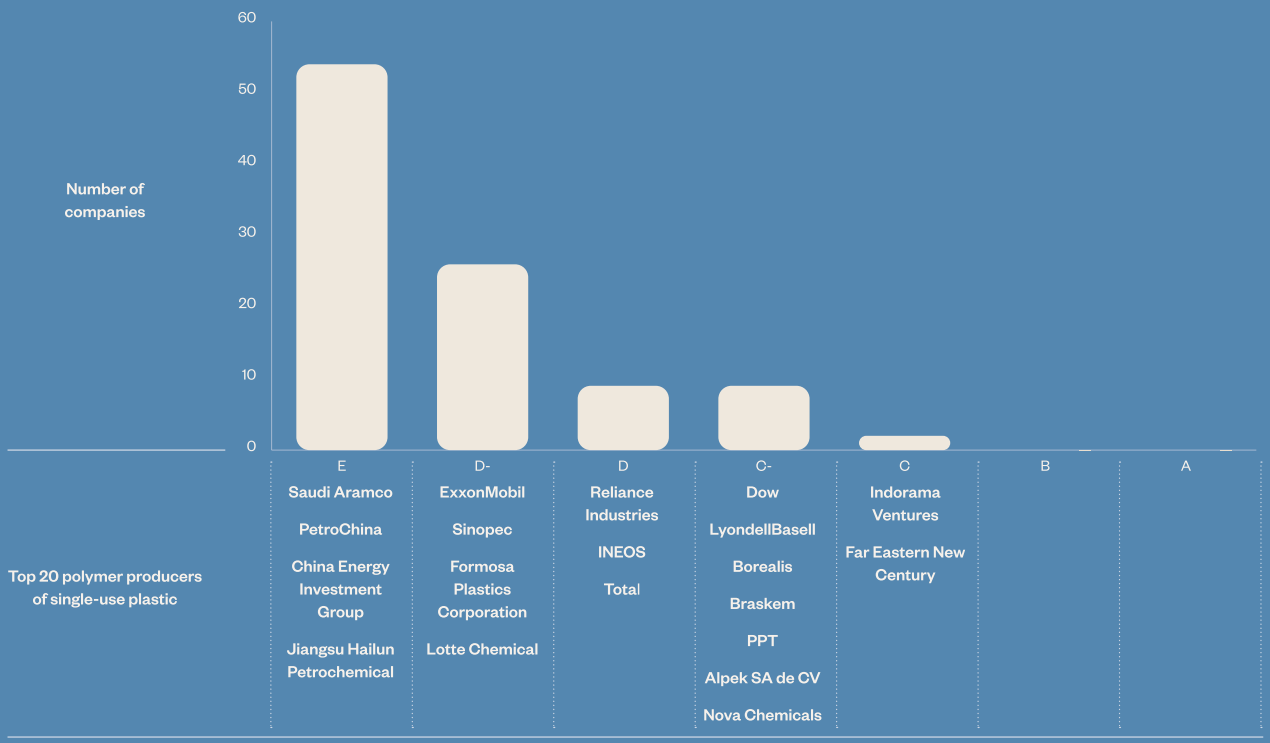
The two companies that received the best grade – Thailand-based Indorama Ventures and Taiwan-based Far Eastern New Century, which both scored a "C" – performed better than their peers due to the predominance of PET in their products (a more widely recycled plastic), as well as having clear circularity policies, commitments and targets, and evidence of engagement with customers and suppliers to create a more sustainable supply chain.[20,21]

Polymer producers headquartered in China and the Middle East typically scored lower than their peers, indicating looser disclosure and reporting requirements and commensurately less focus on circularity in these regions.

Despite many polymer producers having sustainability statements and goals, 54 out of 100 companies in this study received an "E" grade for circularity – the lowest grade possible. Photo credit: Bloomberg Creative via Getty Images.

Figure 6

Overall circularity scores for the top 100 polymer producers, and the top 20 in their respective cohort. A score of 'A' implies a fully circular business model, whereas an 'E' score indicates a company has made no commitments or progress in reducing fossil-fuel derived plastic.



*Data covered by KPMG assurance

Implications

- The transition to a circular plastics economy is moving at glacial speed among polymer producers, yet these very same companies are key to solving the single-use plastic waste crisis. This is likely due to the sector having been relatively shielded from the consumer and regulatory backlash against plastic pollution – which has been focused mainly on the "downstream users" of single-use plastics: packaged goods brands and retailers.
- Polymer producers must commit to using recycled plastic waste and other sustainable feedstocks – and set a clear and unambiguous end-date for no "new" plastics from fossil fuels. But we need more than good intentions and commitments – there must be action, and companies must publish their performance against their targets.
- A common reporting framework is urgently needed to monitor and evaluate progress towards circular plastics production – for example, Ellen MacArthur Foundation's *Circulytics* reporting tool.

POLYMER PRODUCERS HAVE BEGUN TO RESPOND WITH DEFINITIVE PROJECTS THAT POINT TOWARDS A CIRCULAR FUTURE FOR SINGLE-USE PLASTICS

Some of the largest polymer producers are now moving into investing and scaling new recycling technologies. Whilst this section contains a subset of possible examples, these examples are indicative of progress towards the use of affordable recycled plastics to replace virgin feedstocks via innovation and incentivised regulations.

In recent years, Europe has introduced some of the most progressive policies globally to tackle single-use plastic waste. The 2019 EU Single-Use Plastic Directive, for example, requires all PET bottles to contain 25 per cent recycled polymer by 2025 and all plastic bottles to contain 30 per cent recycled content by 2030. Policies have been further strengthened in the 2021 EU Green Deal and coronavirus pandemic recovery package.

This regulatory climate has resulted in Europe emerging as a case study for the possibility of a circular plastics economy. We observe concrete examples of genuinely closed-loop recycling projects – where plastic waste is recycled back into new polymers capable of performing the same applications – being built at commercial scale by several of the world's largest polymer producers.

While collectively these projects add up to only a fraction of current polymer production in Europe, they offer glimpses of an alternative, sustainable future for single-use plastics economy. The shared challenge now – for industry, financial institutions and governments – is to direct the necessary resources, investment and attention to ensure these nascent projects are scaled and replicated, and goals are made far more ambitious.

Australia, China, Indonesia and the United States, are among the growing number of countries signaling intent to create the right regulatory frameworks that will transform the single-use plastics economy into being sustainable and circular.

Other policy-makers are behind the curve and urgent work is required to create greater incentives for recycled polymer production. In India, for example, closed-loop recycling for food-grade single-use plastics is currently prohibited – stalling investment from polymer producers focused on the domestic Indian market such as Reliance Industries, GAIL India and the Indian Oil Corporation

1. The Borealis group of companies includes two mechanical recycling companies, mtm plastics in Germany (since 2016) and Ecoplast in Austria (since 2018). In 2021, Borealis commenced a new project for a chemical recycling unit to be established in Stenungsund, Sweden, with project partner Stena Recycling. Provided a successful feasibility study and final investment decision, operations are expected to begin in 2024. By 2025, Borealis aims to have increased the output of its recycled plastic to 350,000 million metric tons per year.[22]
2. Dow, in 2021, announced a partnership with chemical recycler Mura Technology to support the scale-up and purchase of plastic waste-derived feedstocks, including multilayer packaging, from their development in Teesside, UK, with the first 20,000 million metric tons per year line expected to be operational in 2022 and grow to 80,000 million metric tons per year within a few years. Dow will use these materials to develop new, virgin-grade plastic.[23]
3. ExxonMobil is collaborating with Plastic Energy on an advanced recycling project in Notre Dame de Gravenchon, France, that will convert post-consumer plastic waste into raw materials for the manufacturing of virgin-quality polymers. The project is expected to have initial capacity of 25,000 million metric tons of plastic waste per year.[24]
4. Indorama Ventures plans to invest US$1.5 billion to grow its global rPET capacity to 750,000 million metric tons of by 2025. They announced, in 2020, a new recycling plant in Verdun, France, which, along with recent acquisitions in Poland, will work with their existing PET flake production facilities in Europe. The new facility will provide washed and shredded post-consumer bottles as PET flake feedstock to produce rPET resin that is suitable for food contact use.[25]
5. INEOS has partnered with recycling and waste management company, Viridor, in a project that will produce a range of high-specification polymers with up to 50 per cent or more post-consumer recycled content. INEOS will be supplied with recovered polymer from Viridor's post-consumer polymers recycling plant near Bristol, UK. This follows an announcement that INEOS and Plastic Energy are to build a new pyrolysis-based chemical recycling plant to come on stream at the end of 2023. The plant will input around 30,000 million metric tons per year of mixed and multi-layer plastics as part of 2025 target to Incorporate at least 325 kilotons per year of recycled material into products.[26]

6. LyondellBasell has a goal of producing and marketing two million metric tonnes of recycled and renewable-based polymers annually by 2030. The company is taking a multi-pronged approach that includes the formation of a mechanical recycling joint venture with Suez called Quality Circular Polymers. LyondellBasell is also developing a proprietary advanced recycling technology called MoReTec. This technology aims to return post-consumer plastic waste to its molecular form for use as a feedstock for new plastic materials. LyondellBasell is also producing new polymer material using renewable-based feedstocks including used cooking oil.[27]
7. SABIC, in which Saudi Aramco is 70 per cent shareholder, along with partner Plastic Energy, has started construction on a commercial unit to significantly upscale production of certified circular polymers derived from used plastic, which will be based in Geleen, the Netherlands and is expected to become operational in the second half of 2022.The partnership has previously demonstrated a closed-loop operating model whereby plastic packaging from UK-based retailer, Tesco, is retuned to stores, recycled and used by suppliers for new product packaging.[28]
8. Sinopec has invested in LanzaTech with a focus on promoting direct production of chemicals from alternative circular feedstocks. In 2020, LanzaTech announced the production of the first cosmetics packaging made from industrial carbon emissions with Clichy, France-based, L'Oréal.[29]
9. Total has committed to produce 30 per cent recycled polymers by 2030. One of the first petrochemical companies to make such a commitment. Total announced the creation of a strategic partnership with chemical recycler Plastic Energy, in 2020, for the development of the first chemical recycling project in Grandpuits, France. This plant, with a capacity of 15,000 million metric tons per year, is expected to become operational in early 2023. Total has also announced a partnership with PureCycle aimed at extending their plant capacity into Europe.[30]

INSIGHT 4

Planned expansion of "virgin" polymer capacity threatens to overwhelm hopes of a circular plastics economy.

Producers of the five primary single-use plastic polymers plan to increase capacity by 30 per cent – an additional 70 million metric tons – in the next five years, with 60 per cent of that growth driven by just twenty polymer producers. This represents an annualised growth rate of approximately five per cent per year until 2025, in line with historical growth in demand for single-use plastics from 2005-19.

The three companies projected to create the most additional capacity by 2025 are Sinopec (36 per cent growth), ExxonMobil (+35 per cent) and PetroChina (+38 per cent), however even higher growth rates are predicted for Russian-owned SIBUR (+240 per cent) and Indian HPCL-Mittal Energy Ltd (+343 per cent; Figure 7).

Chinese producers account for almost half of all virgin capacity expansion plans – presumably to reduce reliance on imported polymers. China is the largest importer of polymers for production of single-use plastics globally, at more than 20 million metric tons in 2019. Russian and Middle Eastern companies contribute the next largest share of growth – likely seeking to exploit abundant reserves of economically-advantaged natural gas feedstock to serve export markets.

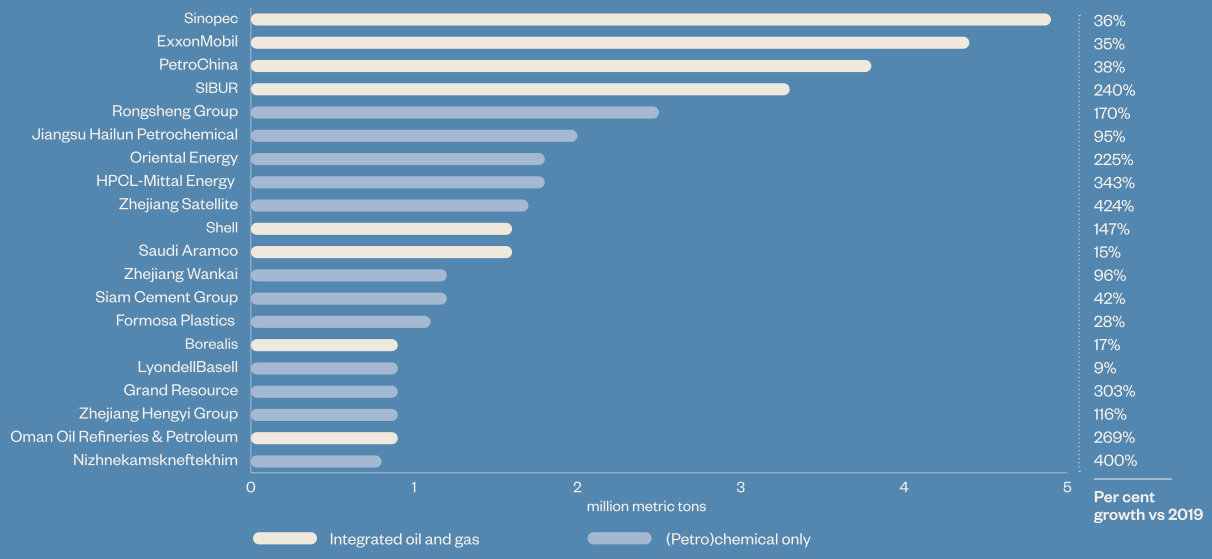
Outside of China, the majority of high-growth producers are integrated oil and gas companies whose operations extend "upstream" into fossil fuel exploration and production – doubling down on plastics as their "soft landing" as energy and fuel markets decarbonise.[31] In China, by contrast, (petro)chemicals companies, which focus only on the conversion of fossil fuels into products such as plastic polymers, are predominant.

Our analyses suggest that, by 2025, the world will have generated – as waste –at least one trillion extra 1-litre drink bottles and caps, one trillion extra bags and one trillion extra metres of kitchen film.

The business case for the growth in single-use plastic polymer production rests on projections that demand will rise in developing economies. But waste collection and recycling infrastructure in these economies is often immature: "business as usual" increases in single-use plastic consumption will overwhelm their infrastructure, with the vast majority ending up as pollution on land and in the ocean.

Figure 7

Top 20 polymer producers adding virgin polymer capacity 2020-2025



Implications

- The ultimate light on the hill is no new single-use plastics from virgin polymers and production of safe sustainable plastics, but a more immediate objective must be to stop the growth in virgin polymer production.
- The business models of (petro)chemicals companies are less intricately bound up in the exploration, production and refining of fossil fuels compared to integrated oil and gas companies. In theory, at least, they should be more agnostic to types of feedstock, and they have an opportunity to show real environmental leadership by differentiating themselves from integrated oil and gas companies and ending expansion of virgin polymer production.
- If growth in demand for single-use plastics fails to keep up with growth in production, over-supply will result – a scenario that could be lethal for the transition to a sustainable circular plastics economy. Virgin polymer prices will likely be depressed, and consequently maintain, or even increase, their economic advantage over recycled polymers. Efforts to bring innovative substitute materials and re-use models to market at scale will also be commercially challenged – and greater intervention from policymakers will be required.

Plastic polymer production impacts both planet and people in every step of the life-cycle from manufacture, to use and disposal. Photo credit: Douglas Sacha via Getty Images.

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Roughly half of all single-use plastic polymers are produced for export. State-owned enterprises are among the largest exporters. Photo credit: Owngarden via Getty Images.

INSIGHT 5

Single-use plastics are an entrenched geopolitical problem.

Our analysis of plastic polymer supply chains reveals the truly global nature of the problem – and illustrates that any solution will need to take into account four complex geopolitical issues:

1. **High levels of state ownership.** Our analysis of equity holdings in these polymer producers reveals that more than 30 per cent of the sector's shareholdings by value are held by state or sovereign actors, primarily in China and the Middle East (Figure 8). And we estimate that the total equity value of this specific industry sub-sector – the production of virgin polymers generating single-use plastic waste – is more than US$60 billion.
2. **The single-use plastic trade is international and high-intensity.** Roughly half of all the five polymers in the scope of our analysis (more than 90 million metric tons (MMT)) were exported in 2019. The top five exporting countries are Saudi Arabia (14 MMT), United States (11 MMT), South Korea (7 MMT), Belgium (6 MMT) and Germany (4 MMT).
3. **Global trade imbalances** in which countries produce/profit versus import/pay for waste management. With the exception of India, all low and lower-middle-income countries are heavy net importers of single-use plastic polymers. Flooded with cheap virgin polymers – predominantly from high-income countries and a few middle-income petrostates – these countries are struggling to manage plastic waste and efforts to transition to a circular economy are being undermined.
4. **Striking differences in national rates of single-use plastic waste generation.** Our analysis of volumes of single-use plastic waste generated in over 100 countries indicates that the average person generates just over 15 kg of single-use plastic waste per year (Figure 9). Some of the highest rates (more than 50 kg per person per year) occur in Australia and the US. In contrast, the average person in China – the largest producer of single-use plastic by volume – produces 18 kg of single-use plastic waste per year; in India that figure is as low as four kg per year.

Implications

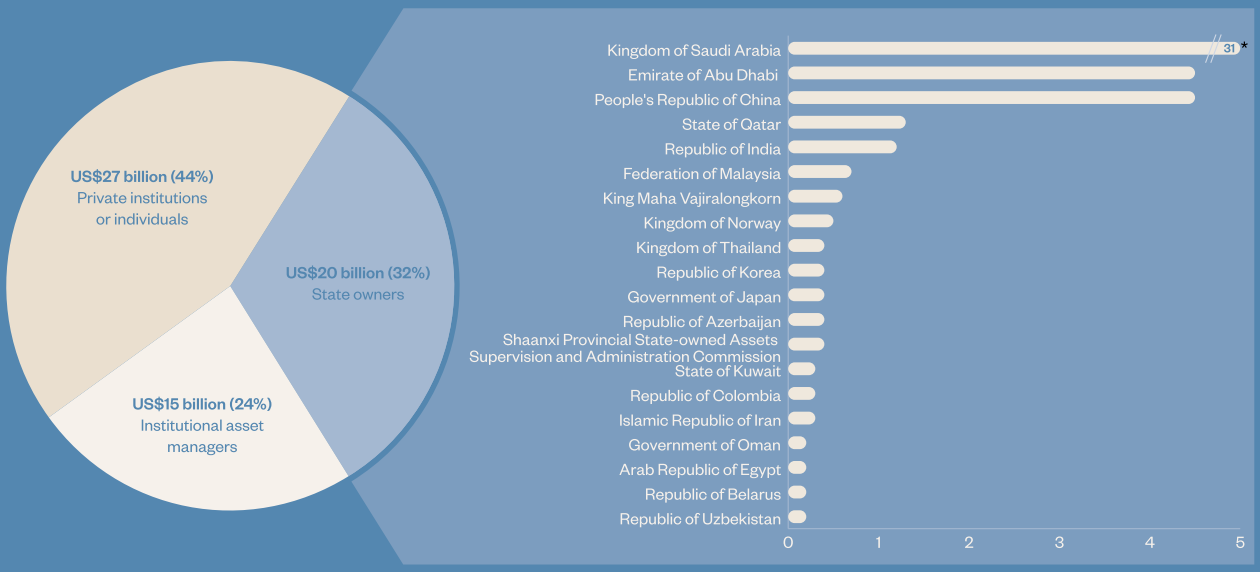
No single country can solve this crisis alone. We believe that a legally-binding international instrument – a Montreal Protocol or Paris Agreement for plastic pollution – must be part of the solution.[32] Such a treaty would be uniquely placed to handle the competing interests of state actors and the asymmetrical nature of single-use plastic production and consumption, and to avoid trade/tariff wars.

More than two-thirds of UN member states have publicly expressed a willingness to consider a global treaty, but progress is slow: international plastic pollution agreements are now where climate change agreements were in 1992. Waiting a further 20 years for an effective agreement would spell disaster for the environment and our health.[33,34]

Ideally, the treaty would adopt a life-cycle approach to the single-use plastic crisis, covering both the reduction and phase-out of new virgin plastic production and improved collection and recycling.[35] Targets should also include phased commitments to minimum recycled content in plastic polymers destined for single-use applications, that ratchet up over time.

Figure 8

Equity ownership of top 200 polymer producers, by investor class. Total value of shareholder's equity adjusted for share of business from in-scope polymer production, US$BN (on 6 January 2021)



*Result excluded from the comparison of ownership by investor class (given the very large market capitalisation of Saudi Aramco – approximately US$2 trillion – of which Kingdom of Saudi Arabia is approximately 90 per cent owner).

*Data covered by KPMG assurance

Figure 9

Top 20 countries generating single-use plastic waste, ranked by per capita consumption

*Data covered by KPMG assurance

WHERE TO NEXT?

A lack of disclosure requirements for producers of single-use plastics has created an accountability gap that neither rewards pioneer companies nor encourages positive practices. It also means many policy-makers lack visibility of material and financial flows through the single-use plastic supply chain, preventing effective policies from being created and enforced.

Minderoo Foundation and its partners acquired multiple industry and trade datasets to understand the single-use plastic supply chain. We carried out months of painstaking investigation to connect single-use plastic waste back to polymer producers. Data from 2019 is the benchmark year zero, but we will update these analyses in the years to come. The unprecedented level of transparency created by this first report must draw a deep line in sand. There is no longer plausible deniability about the sources of single-use plastic waste.

We call on polymer producers to support our efforts, building on our method and providing estimates of their "single-use plastic waste footprint" using internal data. We reserve the right to improve our analysis by liaising with group Chief Financial Officers and their auditors, and will undertake to update the results should there be material changes arising from better understanding of verified data. Companies should also embrace other voluntary reporting initiatives that have emerged recently, such as the Global Commitment for the New Plastics Economy, an initiative from the Ellen MacArthur Foundation, in collaboration with the UN Environment Program. Currently, a desultory two of the 100 companies (Borealis and Indorama) are signatories.

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Plastic is a daily part of life for humans, and sadly for many marine species too, including this Goby fish who is using a plastic bottle as a nest. Photo credit: _548901005677 via Getty Images.

Regulated reporting requirements for companies that are producing (and using) single-use plastics trail far behind those of carbon emissions – and are not commensurate with the high level of risk posed. Reporting needs to be made mandatory, and we support the development of international reporting and accounting standards.[36]

In the interim, we hope that the results and methodologies presented here will be used to inform decision-making by the plastics industry, financial institutions and policy-makers with respect to single-use plastic waste generation, mitigation and reduction. We believe the results and methodologies can serve as an important tool as they (1) allow comparison of results across companies, countries and regions; (2) are repeatable (annually); (3) allow trends to be monitored; and (4) can, in time, be combined with data on waste management and end-of-life material flows as they become available.

We urgently need polymer producers to turn all their expertise and investment away from producing fossil-fuel-based products and towards using plastic waste as feedstock for recycled polymers. We need to see banks and investors re-direct their capital in support of circular production. We need to see policy-makers set domestic and international policies that remove the economic advantage of virgin polymers and support circular models of single-use plastic production. And, finally, we need to see other companies in the single-use plastic supply chain – converters, brands and retailers – commit to designing and sourcing circular plastics for the long-term.

Piles of separated recyclables inside waste facility in Slovinia. Photo credit: AzmanL via Getty Images.

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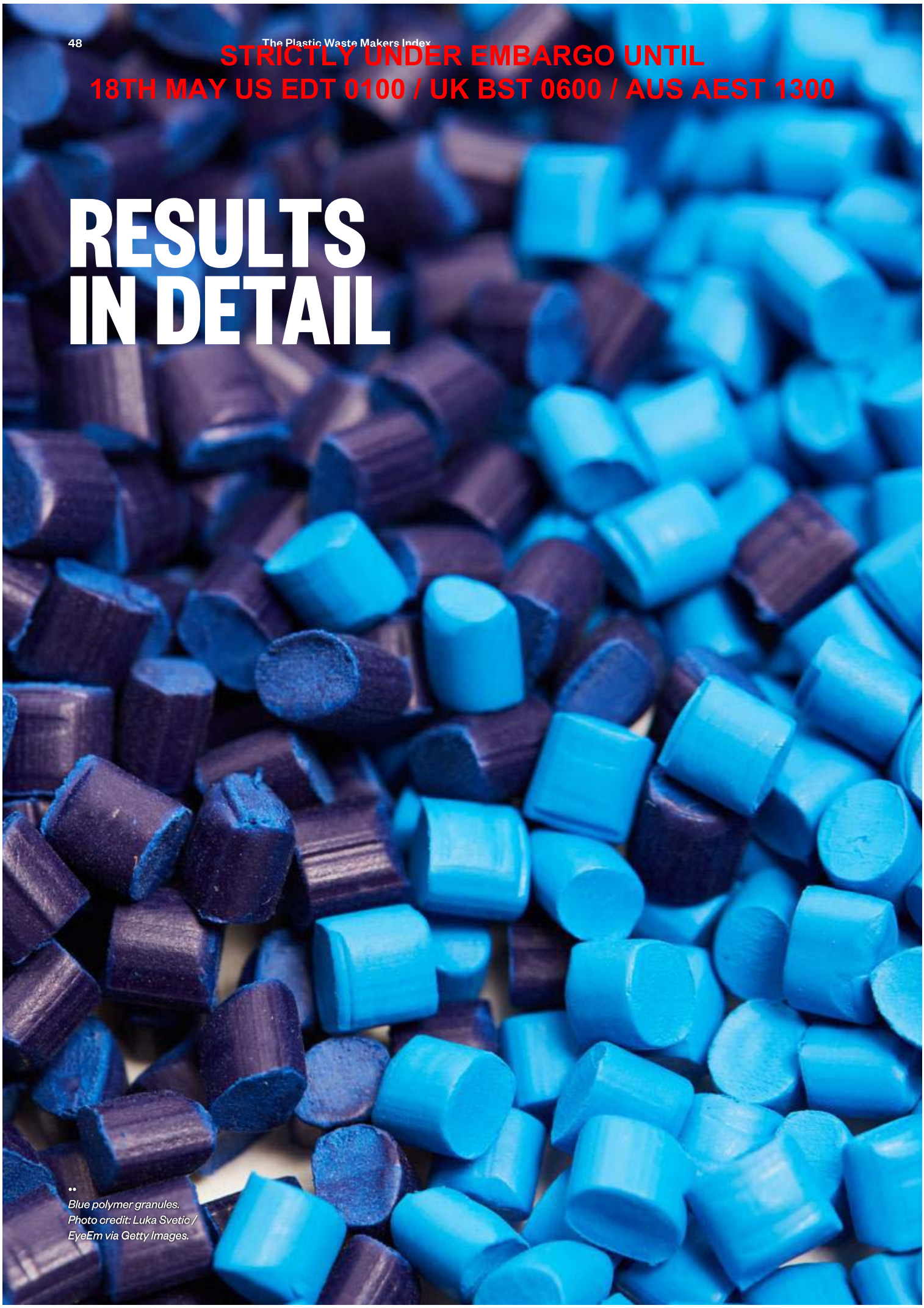
RESULTS IN DETAIL



Blue polymer granules. Photo credit: Luka Svetic / EyeEm via Getty Images.

TOP 100

Polymer producers generating single-use plastic waste: The Plastic Waste Makers Index

Rank	Polymer producer	No. of assets producing in-scope polymers	Estimated production of in-scope polymers (MMT, 2019)	Estimated contribution to single-use plastic waste (MMT, 2019)		Total contribution to single-use plastic waste (MMT, 2019)
				Flexible formats	Rigid formats	
1	ExxonMobil	55	11.2	4.7	1.2	5.9
2	Dow	54	9.3	4.7	0.9	5.6
3	Sinopec	82	11.6	4.0	1.3	5.3
4	Indorama Ventures	26	5.1	0.2	4.5	4.6
5	Saudi Aramco	53	9.5	3.2	1.1	4.3
6	PetroChina	62	8.8	3.3	0.8	4.0
7	LyondellBasell	69	9.3	2.1	1.8	3.9
8	Reliance Industries	26	5.5	1.8	1.3	3.1
9	Braskem	40	6.7	1.9	1.1	3.0
10	Alpek SA de CV	12	2.5	0.0	2.3	2.3
11	Borealis	29	5.0	1.5	0.7	2.2
12	Lotte Chemical	24	4.1	1.1	1.0	2.1
13	INEOS	28	4.8	1.0	1.0	2.0
14	Total	34	4.5	1.0	0.9	1.9
15	Jiangsu Hailun Petrochemical	1	1.7	0.0	1.6	1.6
16	Far Eastern New Century	7	1.6	0.0	1.6	1.6
17	Formosa Plastics Corporation	22	3.6	1.0	0.6	1.6
18	China Energy Investment Group	12	3.4	1.2	0.3	1.5
19	PTT	17	3.1	1.1	0.3	1.5
20	China Resources	4	1.4	0.0	1.3	1.3
21	Nova Chemicals Corporation	8	1.9	1.0	0.2	1.2
22	Siam Cement Group	12	2.4	0.9	0.3	1.1
23	Phillips 66	27	2.4	0.6	0.5	1.0
24	Zhejiang Wankai	4	1.0	0.0	1.0	1.0
25	Sumitomo Chemical	17	2.0	0.7	0.3	1.0
26	Jiangyin Chengxing Industrial Group	7	1.0	0.0	0.9	0.9
27	Chevron Corporation	21	2.2	0.5	0.4	0.9
28	Hanwha Chemical	18	1.6	0.7	0.2	0.9
29	China Coal	7	1.8	0.7	0.1	0.8

Rank	Polymer producer	No. of assets producing in-scope polymers	Estimated production of in-scope polymers (MMT, 2019)	Estimated contribution to single-use plastic waste (MMT, 2019)		Total contribution to single-use plastic waste (MMT, 2019)
				Flexible formats	Rigid formats	
30	Rongsheng Group	9	1.2	0.2	0.7	0.8
31	Mitsubishi Chemical Corporation	20	1.7	0.5	0.4	0.8
32	SIBUR	13	1.3	0.4	0.4	0.8
33	Abu Dhabi National Oil Company	10	1.9	0.6	0.2	0.8
34	GAIL India	14	1.6	0.6	0.1	0.7
35	LG Chem	7	1.4	0.5	0.2	0.7
36	Westlake Chemical Corporation	10	1.0	0.5	0.1	0.6
37	Mitsui Chemicals	17	1.1	0.2	0.4	0.6
38	Sasol	5	1.2	0.5	0.1	0.6
39	Zhejiang Hengyi Group	2	0.6	0.0	0.6	0.6
40	Eni	8	1.0	0.5	0.1	0.6
41	Yanchang Group	7	1.5	0.4	0.1	0.6
42	Repsol	12	1.1	0.4	0.2	0.6
43	Indian Oil Corporation	6	1.2	0.5	0.1	0.6
44	Nan Ya Plastics Coporation	2	0.5	0.0	0.5	0.5
45	SK Innovation Co	10	1.1	0.4	0.1	0.5
46	Oil and Natural Gas Corporation	1	1.2	0.4	0.1	0.5
47	Octal	6	0.6	0.0	0.5	0.5
48	JBF Industries	3	0.5	0.0	0.5	0.5
49	MOL Hungarian Oil and Gas	7	1.1	0.3	0.2	0.5
50	Bakhtar Petrochemical	6	1.0	0.4	0.1	0.5
51	Shell	14	1.0	0.3	0.1	0.4
52	Neo Group	1	0.4	0.0	0.4	0.4
53	Haldia Petrochemicals Ltd	5	0.9	0.3	0.1	0.4
54	China National Offshore Oil Corporation	6	0.8	0.3	0.1	0.4
55	Tasnee	2	0.9	0.3	0.1	0.4
56	Eastern Petrochemical Company	6	0.7	0.3	0.0	0.4
57	Qatar Petroleum	0	0.6	0.3	0.1	0.4
58	Shinkong	16	0.4	0.0	0.4	0.4
59	Sahara International Petrochemical	4	0.8	0.2	0.1	0.3
60	Air Liquide	7	0.7	0.3	0.1	0.3
61	Formosa Chemicals & Fibre Corporation	4	0.6	0.1	0.2	0.3
62	Korea Petrochemical Industrial	6	0.9	0.2	0.1	0.3
63	Gatron Industries	1	0.4	0.0	0.3	0.3
64	Equate Petrochemical Company	5	0.6	0.1	0.2	0.3
65	Baofeng	6	0.7	0.2	0.1	0.3
66	National Petrochemical Company (Saudi Arabia)	3	1.0	0.2	0.1	0.3
67	PT Chandra Asri Petrochemical	8	0.6	0.2	0.1	0.3
68	PKN Orlen	6	0.8	0.1	0.2	0.3
69	Dhunseri Petrochem	2	0.3	0.0	0.3	0.3
70	Bazan Group	4	0.7	0.2	0.1	0.3
71	Daelim Group	7	0.7	0.2	0.1	0.3
72	KAP Industrial Holdings	3	0.5	0.0	0.2	0.3
73	Petroleos Mexicanos	7	0.5	0.2	0.1	0.3
74	Pucheng Clean Energy	3	0.6	0.2	0.1	0.3
75	Qatar Petrochemical Company	4	0.4	0.2	0.0	0.3

Rank	Polymer producer	No. of assets producing in-scope polymers	Estimated production of in-scope polymers (MMT, 2019)	Estimated contribution to single-use plastic waste (MMT, 2019)		Total contribution to single-use plastic waste (MMT, 2019)
				Flexible formats	Rigid formats	
76	TK Chemical	1	0.3	0.0	0.3	0.3
77	Saudi Kayan	3	0.7	0.2	0.1	0.3
78	Oriental Energy	2	0.7	0.2	0.1	0.3
79	Jam Petrochemical Company	4	0.7	0.2	0.1	0.3
80	Nizhnekamskneftekhim	3	0.4	0.2	0.0	0.3
81	Prime Polymer	2	0.4	0.3	0.0	0.3
82	Yansab	3	0.6	0.2	0.0	0.3
83	Petronas	5	0.5	0.2	0.1	0.2
84	Amir Kabir Petrochemical Company	4	0.5	0.2	0.0	0.2
85	State Oil Company of Azerbaijan Republic	7	0.5	0.2	0.1	0.2
86	Henan Coal Chemical Industry Group	1	0.2	0.0	0.2	0.2
87	Fude Energy	2	0.6	0.2	0.1	0.2
88	USI Group	5	0.4	0.2	0.0	0.2
89	Ecopetrol	3	0.5	0.1	0.1	0.2
90	Idemitsu Kosan	10	0.5	0.1	0.1	0.2
91	Kazanorgsintez	6	0.6	0.2	0.1	0.2
92	HPCL-Mittal Energy Ltd	1	0.5	0.2	0.0	0.2
93	Pan Asia PET Resin	1	0.2	0.0	0.2	0.2
94	Koksan	1	0.2	0.0	0.2	0.2
95	Novapet	1	0.2	0.0	0.2	0.2
96	Xingxing	2	0.5	0.1	0.1	0.2
97	Sanyuan	2	0.5	0.1	0.1	0.2
98	North Huajin	4	0.6	0.1	0.1	0.2
99	Shahid Tondgooian Petrochemical	4	0.2	0.0	0.2	0.2
100	Dragon Special Resin	1	0.2	0.0	0.2	0.2

TOP 100

Equity owners of polymer producers

Rank	Owner of equity in companies producing polymers for single-use plastic applications	Location	Investor type	Number of companies invested	Estimated total value of shareholdings (US$BN)	Estimated value adjusted for share of business from in-scope polymer production (US$BN)
1	Kingdom of Saudi Arabia	Saudi Arabia	State Owner	23	1,896.4	31.0
2	People's Republic of China	China	State Owner	28	192.2	6.0
3	Emirate of Abu Dhabi	UAE	State Owner	8	N/A	4.5
4	Ambani Family	India	Private Institution or Individual	1	65.8	2.5
5	Vanguard Group	United States	Institutional Asset Manager	97	68.9	2.2
6	Canopus International	Thailand	Private Institution or Individual	1	4.7	2.2
7	BlackRock	United States	Institutional Asset Manager	88	65.9	1.9
8	Capital Group	United States	Institutional Asset Manager	19	28.9	1.8
9	Mr James Arthur Ratcliffe	Monaco	Private Institution or Individual	1	N/A	1.8
10	East Step International Holdings	Hong Kong	Private Institution or Individual	1	9.1	1.6
11	Zhejiang Rongsheng Holding Group	China	Private Institution or Individual	1	18.5	1.3
12	State of Qatar	Qatar	State Owner	5	5.2	1.3
13	Republic of India	India	State Owner	8	42.3	1.2
14	State Street	United States	Institutional Asset Manager	91	30.9	1.0
15	Access Industries	United States	Private Institution or Individual	1	6.9	1.0
16	Magna Resources Corp	Singapore	Private Institution or Individual	1	5.7	0.9
17	Chang Gung Medical Foundation	Taiwan	Private Institution or Individual	3	7.5	0.8
18	TTWF	United States	Private Institution or Individual	1	7.8	0.7
19	Federation of Malaysia	Malaysia	State Owner	6	11.6	0.7
20	PPH Polymer Products Holdings	Cyprus	Private Institution or Individual	1	N/A	0.6
21	King Maha Vajiralongkorn	Thailand	State Owner	2	6.4	0.6
22	Mr Andrew Christopher Currie	Monaco	Private Institution or Individual	1	N/A	0.6
23	Mr John Reece	Monaco	Private Institution or Individual	1	N/A	0.5
24	FMR	United States	Institutional Asset Manager	81	16.4	0.5
25	Mr Leonid Viktorovich Mikhelson	N/A	Private Institution or Individual	1	N/A	0.5
26	Kingdom of Norway	Norway	State Owner	71	20.2	0.5
27	Credit Suisse Group	Switzerland	Institutional Asset Manager	64	3.9	0.4
28	Kingdom of Thailand	Thailand	State Owner	4	27.1	0.4
29	Republic of Korea	South Korea	State Owner	16	12.5	0.4
30	Lotte Holdings	Japan	Private Institution or Individual	1	2.6	0.4
31	Government of Japan	Japan	State Owner	72	14.9	0.4
32	Stock Exchange of Thailand	Thailand	Private Institution or Individual	5	4.5	0.4

Rank	Owner of equity in companies producing polymers for single-use plastic applications	Location	Investor type	Number of companies invested	Estimated total value of shareholdings (US$BN)	Estimated value adjusted for share of business from in-scope polymer production (US$BN)
33	Republic of Azerbaijan	Azerbaijan	State Owner	2	0.9	0.4
34	"Shaanxi Provincial State-owned Assets Supervision And Administration Commission"	China	State Owner	1	N/A	0.4
35	Taif AO	Russia	Private Institution or Individual	2	1.6	0.4
36	Yan An Shi Guo Zi Wei	N/A	Private Institution or Individual	1	N/A	0.3
37	Saudi Industrial Investment	Saudi Arabia	Private Institution or Individual	1	2.1	0.3
38	Kieppe Patrimonial	Brazil	Private Institution or Individual	1	1.4	0.3
39	State of Kuwait	Kuwait	State Owner	5	0.1	0.3
40	Pangestu Family	Indonesia	Private Institution or Individual	1	1.8	0.3
41	Republic of Colombia	Colombia	State Owner	1	24.4	0.3
42	"Jiang Yin Cheng Xing Shi Ye Ji Tuan You Xian Gong Si Gong Hui Wei Yuan Hui"	N/A	Private Institution or Individual	1	N/A	0.3
43	General Organization For Social Insurance	Saudi Arabia	Private Institution or Individual	3	1.8	0.3
44	Chin's International Investment	N/A	Private Institution or Individual	3	2.4	0.3
45	Dimensional Fund Advisors	United States	Institutional Asset Manager	89	7.7	0.3
46	Islamic Republic of Iran	Iran	State Owner	6	N/A	0.3
47	National Bank Trust	Russia	Private Institution or Individual	1	N/A	0.3
48	Geode Capital Management	United States	Institutional Asset Manager	58	7.6	0.3
49	Genhero Limited	N/A	Private Institution or Individual	1	N/A	0.2
50	Mr Gennadii Nikolaevich Timchenko	N/A	Private Institution or Individual	1	N/A	0.2
51	Government of Oman	Oman	State Owner	1	N/A	0.2
52	Mr Asim Kokoglu	N/A	Private Institution or Individual	1	N/A	0.2
53	Kavosh Sanat Sepid Company	N/A	Private Institution or Individual	1	N/A	0.2
54	Northern Trust Corp	United States	Institutional Asset Manager	60	7.5	0.2
55	Wan Shun International Investment	N/A	Private Institution or Individual	3	1.8	0.2
56	JPMorgan Chase	United States	Institutional Asset Manager	70	9.9	0.2
57	Bank of New York Mellon	United States	Institutional Asset Manager	66	6.9	0.2
58	Lianyungang Bochuang Investment	N/A	Private Institution or Individual	1	N/A	0.2
59	Arab Republic of Egypt	Egypt	State Owner	3	N/A	0.2
60	Bangkok Bank	Thailand	Institutional Asset Manager	4	1.0	0.2
61	Cristian Lay	N/A	Private Institution or Individual	1	N/A	0.2
62	Dang Yanbao	N/A	Private Institution or Individual	1	1.1	0.2
63	Credit Agricole Group	France	Institutional Asset Manager	66	12.9	0.2
64	Republic of Belarus	Belarus	State Owner	2	N/A	0.2
65	Jia Dou Guo Ji You Xian Gong Si	N/A	Private Institution or Individual	1	N/A	0.2
66	Mr Jian Chang Zhao	N/A	Private Institution or Individual	1	N/A	0.2
67	Invesco	United States	Institutional Asset Manager	83	5.5	0.2
68	UBS Group	Switzerland	Institutional Asset Manager	73	6.4	0.2
69	Charles Schwab Investment Advisory	United States	Institutional Asset Manager	79	5.6	0.2
70	Republic of Uzbekistan	Uzbekistan	State Owner	1	N/A	0.2
71	TIAA Board of Overseers	United States	Institutional Asset Manager	64	4.5	0.2

Rank	Owner of equity in companies producing polymers for single-use plastic applications	Location	Investor type	Number of companies invested	Estimated total value of shareholdings (US$BN)	Estimated value adjusted for share of business from in-scope polymer production (US$BN)
72	Grupo Inversor Petroquimica	Spain	Private Institution or Individual	1	N/A	0.2
73	Sumitomo Mitsui Trust Holdings	Japan	Institutional Asset Manager	71	5.8	0.2
74	Morgan Stanley	United States	Institutional Asset Manager	59	3.8	0.1
75	Plastipak Holdings	N/A	Private Institution or Individual	1	N/A	0.1
76	SIXB	Cyrpus	Private Institution or Individual	1	N/A	0.1
77	SOIHL Cyprus Investment Limited	Cyprus	Private Institution or Individual	1	N/A	0.1
78	Nx Shengda Rungfeng	N/A	Private Institution or Individual	1	0.8	0.1
79	Li Shuirong	N/A	Private Institution or Individual	1	1.9	0.1
80	Bank of America	United States	Institutional Asset Manager	20	5.6	0.1
81	California Public Employees' Retirement System	United States	Institutional Asset Manager	63	3.8	0.1
82	Wellington Management Group	United States	Institutional Asset Manager	29	5.1	0.1
83	Mittal Investments	India	Private Institution or Individual	1	N/A	0.1
84	Republic of Italy	Italy	State Owner	3	11.8	0.1
85	Samarjit Enterprises	India	Private Institution or Individual	1	3.4	0.1
86	Prudential	Britain	Institutional Asset Manager	68	2.4	0.1
87	Dodge & Cox	United States	Institutional Asset Manager	7	3.1	0.1
88	Wellington Marketing	N/A	Private Institution or Individual	1	N/A	0.1
89	Gresham Banque Privee	Britain	Private Institution or Individual	72	N/A	0.1
90	Republic of Tatarstan	Russia	State Owner	1	0.4	0.1
91	Justice Shares Broker	Iran	Private Institution or Individual	3	N/A	0.1
92	Franklin Resources	United States	Institutional Asset Manager	80	7.0	0.1
93	Federative Republic Of Brazil	Brazil	State Owner	1	0.5	0.1
94	Civil Pension Fund Investment	Iran	Institutional Asset Manager	3	N/A	0.1
95	Xi'an Innovative Energy Investment Management	N/A	Private Institution or Individual	1	N/A	0.1
96	Huan Yang You Xian Gong Si	N/A	Private Institution or Individual	1	N/A	0.1
97	Hua Li Cai Wu You Xian Gong Si	N/A	Private Institution or Individual	1	N/A	0.1
98	Republic of Austria	Austria	State Owner	1	N/A	0.1
99	Mitsubishi UFJ Financial Group	Japan	Institutional Asset Manager	77	N/A	0.1
100	DWS Investment	Germany	Institutional Asset Manager	69	N/A	0.1

TOP 100

Banks financing polymer producers

Rank	Bank	Headquarters	Number of lending and underwriting deals (2011 to 2020)	Number of companies lending and underwriting	Total value of loans and underwriting (US$BN)	Estimated value of loans and underwriting adjusted for share of business from in-scope polymer production, US$BN (from Jan 2011 to Dec 2020)			
						Loans	Equity underwriting	Bonds underwriting	Total
1	Barclays	United Kingdom	477	23	68.3	3.1	0.7	1.5	5.4
2	JPMorgan Chase	United States	636	28	90.5	2.7	0.3	2.0	5.0
3	Citigroup	United States	746	32	96.7	2.8	0.4	1.9	5.1
4	Bank of America	United States	561	27	73.3	2.9	0.1	1.2	4.2
5	HSBC	United Kingdom	600	36	68.5	3.1	0.2	1.4	4.7
6	Mitsubishi UFJ Financial	Japan	599	32	54.3	2.1	0.0	0.8	2.9
7	Deutsche Bank	Germany	340	23	41.7	1.0	0.3	0.9	2.2
8	Mizuho Financial	Japan	571	33	49.1	1.5	0.0	0.7	2.3
9	SMBC Group	Japan	495	32	47.4	1.5	0.0	0.6	2.2
10	Goldman Sachs	United States	320	22	37.5	0.5	0.4	0.7	1.6
11	UniCredit	Italy	173	14	17.3	1.1	0.1	1.0	2.1
12	BNP Paribas	France	445	29	42.5	1.0	0.0	0.7	1.7
13	Credit Suisse	Switzerland	167	15	17.9	0.8	0.2	0.3	1.3
14	Morgan Stanley	United States	377	22	40.9	0.3	0.3	1.0	1.6
15	Crédit Agricole	France	322	25	27.3	1.0	0.0	0.6	1.7
16	Société Générale	France	321	24	31.5	1.0	0.0	0.6	1.6
17	ING Group	Netherlands	178	22	11.5	1.0	-	0.3	1.3
18	NatWest	United Kingdom	163	22	15.4	0.5	0.0	0.1	0.7
19	UBS	Switzerland	117	21	13.7	0.3	0.1	0.3	0.7
20	Bangkok Bank	Thailand	65	5	5.2	0.4	0.1	0.4	0.9
21	Lloyds Banking Group	United Kingdom	79	7	7.9	0.4	-	0.2	0.6
22	Raiffeisen Bank International	Austria	63	4	3.4	0.5	0.0	0.4	0.9
23	Santander	Spain	143	14	15.0	0.3	0.0	0.5	0.8
24	Siam Commercial Bank	Thailand	65	5	6.5	0.3	0.0	0.5	0.8
25	Industrial and Commercial Bank of China	China	203	20	19.2	0.6	-	0.2	0.8
26	Shanghai Pudong Development Bank	China	73	7	8.9	0.4	-	0.5	0.8

Rank	Bank	Headquarters	Number of lending and underwriting deals (2011 to 2020)	Number of companies lending and underwriting	Total value of loans and underwriting (US$BN)	Estimated value of loans and underwriting adjusted for share of business from in-scope polymer production, US$BN (from Jan 2011 to Dec 2020)			
						Loans	Equity underwriting	Bonds underwriting	Total
27	Erste Group	Austria	65	3	3.1	0.4	0.0	0.4	0.8
28	Wells Fargo	United States	310	14	15.1	0.5	0.0	0.3	0.8
29	Scotiabank	Canada	206	16	10.8	0.8	0.0	0.2	1.1
30	Krung Thai Bank	Thailand	65	4	5.7	0.3	0.0	0.4	0.7
31	Commerzbank	Germany	98	11	5.8	0.4	0.0	0.3	0.7
32	Standard Chartered	United Kingdom	279	22	19.5	0.3	-	0.2	0.6
33	Bank of China	China	273	23	23.4	0.3	0.0	0.3	0.6
34	BNDES	Brazil	6	2	2.0	0.5	-	-	0.5
35	ANZ	Australia	118	16	8.7	0.4	-	0.1	0.5
36	Bank of New York Mellon	United States	51	6	4.1	0.4	-	0.0	0.4
37	Taiwan Financial Holding	Taiwan	85	9	2.4	0.5	-	-0.0	0.5
38	Kasikornbank	Thailand	55	4	3.6	0.0	0.0	0.4	0.5
39	Yuanta Financial	Taiwan	73	6	2.1	0.0	0.0	0.4	0.5
40	Intesa Sanpaolo	Italy	117	15	9.0	0.3	-	0.1	0.4
41	Royal Bank of Canada	Canada	159	10	16.6	0.5	0.0	0.2	0.8
42	Regions Financial	United States	23	6	1.8	0.4	-	0.0	0.4
43	Toronto-Dominion Bank	Canada	70	7	5.6	0.7	0.0	0.1	0.8
44	European Investment Bank	Luxembourg	9	5	3.3	0.4	-	0.0	0.4
45	Landesbank Baden-Württemberg (LBBW)	Germany	21	2	1.7	0.2	-	0.2	0.4
46	State Bank of India	India	162	6	14.0	0.3	0.0	0.0	0.3
47	Mega Financial	Taiwan	88	10	2.4	0.3	-	0.1	0.4
48	PNC Financial Services	United States	89	9	4.0	0.4	0.0	0.0	0.4
49	KDB Financial Group	South Korea	77	12	3.3	0.2	-	0.1	0.3
50	Sberbank	Russia	8	1	2.1	0.3	-	0.0	0.3
51	First Abu Dhabi Bank	United Arab Emirates	112	9	11.2	0.3	0.0	0.0	0.3
52	China Minsheng Banking	China	63	7	11.1	0.1	-	0.2	0.3
53	Nordea	Finland	17	5	1.2	0.3	-	-0.0	0.3
54	JBIC	Japan	14	8	12.3	0.3	-	-	0.3
55	Masterlink Securities	Taiwan	38	2	1.2	-	0.1	0.2	0.3
56	Itaú Unibanco	Brazil	8	2	1.2	0.0	-	0.2	0.3
57	China Construction Bank	China	119	11	10.5	0.1	-	0.1	0.3
58	Export Development Canada	Canada	52	9	4.5	0.5	-	-0.0	0.5
59	World Bank	United States	15	3	0.7	0.2	-	-	0.2
60	Northern Trust	United States	16	5	4.7	0.2	-	-	0.2

Rank	Bank	Headquarters	Number of lending and underwriting deals (2011 to 2020)	Number of companies lending and underwriting	Total value of loans and underwriting (US$BN)	Estimated value of loans and underwriting adjusted for share of business from in-scope polymer production, US$BN (from Jan 2011 to Dec 2020)			
						Loans	Equity underwriting	Bonds underwriting	Total
61	BMO Financial Group	Canada	33	8	1.9	0.1	0.0	0.0	0.1
62	Taiwan Cooperative Financial	Taiwan	65	11	1.4	0.2	-	0.0	0.2
63	DZ Bank	Germany	35	7	1.8	0.2	-	0.1	0.3
64	DBS	Singapore	134	12	7.0	0.2	0.0	0.0	0.2
65	Banco Bilbao Vizcaya Argentaria (BBVA)	Spain	99	18	6.8	0.2	0.0	0.1	0.2
66	Hua Nan Financial	Taiwan	76	9	1.6	0.2	-	0.0	0.2
67	Gazprombank	Russia	7	1	1.4	-	0.2	0.1	0.2
68	China Development Financial Holding	Taiwan	60	4	1.0	0.0	-	0.2	0.2
69	Fubon Financial	Taiwan	54	7	1.3	0.1	-	0.1	0.2
70	Agricultural Bank of China	China	103	8	13.1	0.0	-	0.2	0.2
71	Sumitomo Mitsui Trust	Japan	84	11	5.2	0.2	-	-	0.2
72	CTBC Financial Holding	Taiwan	46	8	1.2	0.2	-	0.0	0.2
73	Nomura	Japan	63	10	4.3	0.0	0.0	0.1	0.2
74	China International Capital Corporation	China	68	6	8.1	-	-	0.2	0.2
75	CITIC	China	129	7	10.0	0.0	0.0	0.1	0.2
76	Korea Investment Holdings	South Korea	80	5	3.2	-	0.0	0.2	0.2
77	NongHyup Financial	South Korea	119	5	5.9	0.0	0.0	0.1	0.2
78	Axis Bank	India	50	7	4.9	0.0	0.0	0.1	0.2
79	Chang Hwa Commercial Bank	Taiwan	42	10	0.9	0.2	-	-	0.2
80	Guosen Securities	China	24	4	2.7	-	0.2	0.0	0.2
81	Taishin Financial Group	Taiwan	24	4	0.8	0.1	0.0	0.1	0.2
82	United Overseas Bank	Singapore	86	11	4.9	0.1	0.0	0.0	0.1
83	Bradesco	Brazil	14	1	0.7	0.1	-	0.0	0.1
84	KfW	Germany	22	8	2.8	0.2	-	0.0	0.2
85	Banco do Brasil	Brazil	13	1	0.6	0.1	-	0.0	0.1
86	Industrial Bank Company	China	64	5	9.4	0.0	-	0.1	0.1
87	BPCE Group	France	72	12	6.4	0.1	0.0	0.0	0.1
88	Norinchukin Bank	Japan	41	8	3.0	0.1	-	0.0	0.1
89	DNB	Norway	61	9	4.2	0.1	0.0	0.0	0.1
90	China Merchants Group	China	128	6	9.3	0.0	-	0.1	0.1
91	KB Financial Group	South Korea	96	5	3.2	0.0	0.0	0.1	0.1
92	China Development Bank	China	31	5	4.8	0.1	-	0.1	0.1
93	Korea Eximbank	South Korea	31	9	2.9	0.1	-	-	0.1
94	Riyad Bank	Saudi Arabia	43	4	5.0	0.1	0.0	0.0	0.1

Rank	Bank	Headquarters	Number of lending and under-writing deals (2011 to 2020)	Number of companies lending and underwriting	Total value of loans and underwriting (US$BN)	Estimated value of loans and underwriting adjusted for share of business from in-scope polymer production, US$BN (from Jan 2011 to Dec 2020)			
						Loans	Equity under-writing	Bonds under-writing	Total
95	ICICI Bank	India	84	6	3.6	0.0	0.0	0.1	0.1
96	Far Eastern International Bank	Taiwan	27	3	0.5	0.0	-	0.1	0.1
97	Capital Securities	China	27	2	0.5	-	-	0.1	0.1
98	HDFC Bank	India	25	3	3.2	-	0.0	0.1	0.1
99	CSC Financial	China	79	6	6.3	-	-	0.1	0.1
100	Public Investment Fund	Saudi Arabia	4	2	5.2	0.1	-	-	0.1

TOP 100

Circularity scores

Rank	Largest 100 of in-scope polymer producers ranked by circularity scores	Overall score A to E	Enablers score	Outcome score	Indicators						
					Strategy	Targets	Infra-structure	Supplier engage-ment	Customer engage-ment	Per cent recycled inflows	Per cent outflow not recycled
1	Indorama Ventures	C	A-	D-	A	A	B	B-	B	E	D
2	Far Eastern New Century	C	B	D-	A	B	B	C	B	E	C-
3	Dow	C-	B	E	A	B	C	B-	B	E	E
4	LyondellBasell	C-	B	E	B	B	C	B-	B	E	E
5	Braskem	C-	B	E	A	B	C	C	B	E	E
6	Borealis	C-	A-	E	A	A-	B	B-	B	E	E
7	PTT	C-	B	E	A	B-	B-	C	B	E	E
8	Alpek SA de CV	C-	B-	D-	A	D	B	C-	C	E	D
9	Nova Chemicals Corporation	C-	B	E	A	C	B	C	B	E	E
10	Repsol	C-	B	E	A	B-	B	B-	B	E	D-
11	Mitsui Chemical	C-	B-	E	A	D-	B-	C-	B	E	D-
12	Reliance Industries	D	C	E	C	C-	B	C-	B-	E	D-
13	INEOS	D	C	E	D	B	C	C-	C-	E	E
14	Total	D	B-	E	C	B-	B-	C-	B	E	E
15	Siam Cement Group	D	B-	E	B	B	B-	C	D	E	E
16	LG Chem	D	C	E	A	B	C	C-	E	E	E
17	SIBUR	D	C	E	B	C	C-	C-	B	E	E
18	Shell	D	C-	E	C	C	C	C-	D	E	E
19	Eni	D	C	E	C	E	B-	C	B	E	E
20	KAP Industrial Holdings	D	C	D-	D	E	B	B-	B	E	D
21	Sinopec	D-	C-	E	C	C	C-	D	D-	E	E
22	Lotte Chemical	D-	D-	E	E	E	C	D	D-	E	D-
23	Formosa Plastics Corporation	D-	D	E	D	E	C	D	D-	E	E
24	Chevron Corporation	D-	D	E	C	D	C	D	E	E	E
25	Sumitomo Chemical	D-	D	E	D	D-	D	C	E	E	E
26	Abu Dhabi National Oil Company	D-	C-	E	A	E	D-	C	D-	E	E
27	Mitsubishi Chemical Corporation	D-	C-	E	C	E	B	C-	D	E	D-

Rank	Largest 100 of in-scope polymer producers ranked by circularity scores	Overall score A to E	Enablers score	Outcome score	Indicators						
					Strategy	Targets	Infra-structure	Supplier engage-ment	Customer engage-ment	Per cent recycled inflows	Per cent outflow not recycled
28	China Resources	D-	E	D	D	E	E	E	E	E	C
29	MOL Hungarian Oil & Gas	D-	D	E	C	E	B-	C-	E	E	D-
30	Westlake Chemical Corporation	D-	C-	E	E	E	B	C-	B-	E	E
31	Jiangyin Chengxing Industrial Group	D-	E	D	E	E	E	E	D-	E	C
32	Tasnee	D-	D	E	E	E	B	D	D-	E	E
33	PKN Orlen	D-	D-	E	D	D-	D	E	D-	E	D-
34	Equate Petrochemical Company	D-	D	E	C	E	B-	D	D-	E	D-
35	Octal	D-	D	E	B	E	B-	E	E	E	E
36	Zhejiang Hengyi Group	D-	E	D	D	E	D-	E	E	E	C
37	Nan Ya	D-	D	D-	B	E	B-	E	E	E	D
38	Idemitsu Kosan	D-	D-	E	C	E	C-	D-	E	E	E
39	Petronas	D-	D	E	C	D-	C-	C-	E	E	E
40	Hyosung Corporation	D-	D-	E	E	E	B	E	D	E	E
41	Neo Group	D-	D	D-	D	E	B	E	D-	E	C-
42	USI Group	D-	D-	E	C	E	C-	E	D-	E	E
43	ExxonMobil	D-	D	E	E	E	C	D-	B	E	E
44	Jiangsu Hailun Petrochemical	D-	E	D	E	E	E	E	E	E	C
45	Zhejiang Wankai	D-	E	D	E	E	E	E	E	E	C
46	Phillips 66	D-	D	E	D	C-	C-	D	E	E	E
47	Saudi Aramco	E	E	E	E	E	C	E	E	E	E
48	PetroChina	E	E	E	E	E	E	E	E	E	E
49	China Energy Investment Group Co. Ltd	E	E	E	E	E	E	E	E	E	E
50	China Coal	E	E	E	E	E	E	E	E	E	E
51	Hanwha Chemical	E	E	E	D	E	D	E	E	E	E
52	GAIL India	E	E	E	E	E	D-	E	D-	E	E
53	Yanchang Group	E	E	E	E	E	E	E	E	E	E
54	Rongsheng Group	E	E	D-	E	E	D-	E	E	E	C-
55	Sasol	E	E	E	E	E	E	C	E	E	E
56	Indian Oil Corporation	E	E	E	D	E	D	E	E	E	E
57	Oil & Natural Gas Corporation	E	E	E	D	E	D-	E	D-	E	E
58	SK Innovation Co	E	D-	E	C	E	D	E	D-	E	E
59	Bakhtar Petrochemical	E	E	E	E	E	E	E	E	E	E
60	National Petrochemical Company (Saudi Arabia)	E	E	E	E	E	E	E	E	E	E
61	Haldia Petrochemicals Ltd	E	E	E	D	E	E	E	E	E	E
62	KPIC Corporation	E	E	E	E	E	E	E	E	E	E

Rank	Largest 100 of in-scope polymer producers ranked by circularity scores	Overall score A to E	Enablers score	Outcome score	Indicators						
					Strategy	Targets	Infra-structure	Supplier engage-ment	Customer engage-ment	Per cent recycled inflows	Per cent outflow not recycled
63	China Nation Offshore Oil Corporation	E	E	E	E	E	E	E	E	E	E
64	Sahara International Petrochemical	E	E	E	E	E	D-	E	E	E	E
65	Jam Petrochemical Company	E	E	E	E	E	E	E	E	E	E
66	Eastern Petrochemical Company	E	E	E	E	E	E	E	E	E	E
67	Bazan Group	E	E	E	E	E	E	E	E	E	E
68	Oriental Energy	E	E	E	E	E	D-	E	E	E	E
69	Saudi Kayan	E	E	E	E	E	E	E	E	E	E
70	Ningxia Baofeng Group	E	E	E	E	D-	D	E	E	E	E
71	Daelim Group	E	E	E	E	E	E	E	E	E	E
72	Kazanorgsintez	E	E	E	E	E	E	E	E	E	E
73	North Huajin	E	E	E	E	E	E	E	E	E	E
74	Pucheng Clean Energy	E	E	E	D	E	E	E	E	E	E
75	Formosa Chemical & Fibre Corporation	E	E	E	E	E	E	E	E	E	D-
76	Qatar Petroleum	E	E	E	E	E	E	E	D-	E	E
77	Yansab	E	E	E	E	E	E	E	E	E	E
78	Fude Energy	E	E	E	E	E	E	E	E	E	E
79	PT Chandra Asri Petrochemical	E	D-	E	D	E	D	E	D-	E	E
80	JBF	E	E	D-	E	E	E	E	E	E	C-
81	Xingxing	E	E	E	E	E	E	E	E	E	E
82	Sanyuan	E	E	E	E	E	E	E	E	E	E
83	Amir Kabir Petrochemical Company	E	E	E	E	E	E	E	E	E	E
84	Petroleos Mexicanos	E	E	E	E	E	E	E	E	E	E
85	Ecopetrol S.A.	E	E	E	E	E	E	E	E	E	E
86	State Oil Company of Azerbaijan Republic	E	E	E	E	E	E	E	E	E	E
87	Advanced Petrochemical	E	E	E	E	E	E	E	E	E	E
88	HPCL-Mittal Energy Ltd	E	E	E	E	E	E	E	E	E	E
89	Marun Petrochemical Company	E	E	E	E	E	E	E	E	E	E
90	National Petrochemical Company (Iran)	E	E	E	E	E	E	E	E	E	E
91	Nizhnekams-kneftekhim	E	E	E	E	E	D-	D	E	E	E
92	Qatar Petrochemical Company	E	E	E	E	E	E	E	D-	E	E

Rank	Largest 100 of in-scope polymer producers ranked by circularity scores	Overall score A to E	Enablers score	Outcome score	Indicators						
					Strategy	Targets	Infra-structure	Supplier engage-ment	Customer engage-ment	Per cent recycled inflows	Per cent outflow not recycled
93	Luqing Group	E	E	E	E	E	E	E	E	E	E
94	Pinnacle Polymers Company	E	E	E	E	E	E	E	E	E	E
95	Mesaieed Petrochemical Holding Company	E	E	E	E	E	E	E	E	E	E
96	Lukoil	E	E	E	E	E	E	E	E	E	E
97	Petro Rabigh	E	E	E	E	E	D-	E	E	E	E
98	LCY Chemical Corp.	E	E	E	D	E	E	E	E	E	E
99	Jiutai Energy	E	E	E	E	E	E	E	E	E	E
100	Datang Group	E	E	E	E	E	E	E	E	E	E

STRICTLY UNDER EMBARGO UNTIL
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TOP 100

Countries by per capita single-use plastic waste generation

		In-scope Polymer Production and Trade				Conversion				Single-use plastic bulk packaging trade		Trade of single-use plastic finished goods		Single-use plastic waste generation	
Rank	Country	Domestic production (MMT) +	Exports (MMT) -	Imports (MMT) =	Net polymer production (MMT) -	Volume of out-of-scope application (MMT) =	Converted single-use plastic volume (MMT): Total	Rigid format	Flexible format -	Bulk packaging trade (MMT): Exports +	Imports -	Finished goods trade (MMT): Exports +	Imports =	Net single-use plastic waste generation (MMT)	Single-use plastic waste generation per capita (kg per person)
1	Singapore	4.1	4.1	0.3	0.3	0.2	0.1	0.0	0.1	0.1	0.4	0.4	0.4	0.4	76
2	Australia	0.5	0.1	0.4	0.8	0.5	0.4	0.2	0.2	0.1	0.8	0.1	0.4	1.5	59
3	Oman	0.9	0.6	0.1	0.4	0.1	0.3	0.2	0.1	-	-	0.0	0.1	0.3	56
4	Netherlands	2.7	2.7	1.5	1.5	1.2	0.3	0.1	0.2	1.2	1.4	0.5	0.9	0.9	55
5	Belgium	3.5	3.5	3.4	3.4	2.7	0.8	0.4	0.4	1.0	1.1	0.9	0.6	0.6	55
6	Israel	0.5	0.3	0.5	0.8	0.4	0.4	0.2	0.2	0.1	0.2	0.1	0.1	0.5	55
7	Hong Kong	-	-	0.0	0.0	-	0.0	0.0	-	0.0	0.4	-	-	0.4	55
8	Switzerland	-	-	0.3	0.3	0.2	0.1	0.1	0.0	0.5	0.4	0.1	0.5	0.5	53
9	United States	28.8	10.7	4.6	22.7	9.2	13.6	7.6	5.9	2.4	4.1	2.0	4.0	17.2	53
10	United Arab Emirates	3.9	3.4	0.9	1.3	1.0	0.3	0.2	0.2	0.0	0.1	0.2	0.4	0.5	52
11	Chile	0.1	0.1	0.5	0.5	0.2	0.3	0.1	0.1	0.1	0.6	0.0	0.1	0.9	51
12	South Korea	10.4	6.6	0.5	4.3	1.9	2.4	1.1	1.3	1.1	1.2	0.7	0.5	2.3	44
13	United Kingdom	1.2	0.8	1.5	1.9	0.8	1.2	0.6	0.5	0.4	1.9	0.9	1.2	2.9	44
14	Kuwait	0.9	0.7	0.1	0.4	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.2	40
15	New Zealand	-	-	0.2	0.2	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.2	39
16	Ireland	-	-	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.2	0.2	0.2	0.2	39
17	Finland	0.5	0.4	0.3	0.4	0.2	0.2	0.1	0.2	0.1	0.0	0.1	0.1	0.2	38
18	Japan	5.3	0.8	1.7	6.1	2.6	3.6	2.1	1.5	0.6	1.8	0.9	0.9	4.7	37
19	France	2.7	2.3	2.2	2.6	1.1	1.5	0.9	0.5	1.1	1.9	1.1	1.1	2.3	36
20	Slovenia	-	-	0.2	0.2	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.1	35
21	Saudi Arabia	15.4	13.8	0.4	2.0	0.9	1.1	0.5	0.5	0.3	0.2	0.0	0.2	1.2	35
22	Czech Republic	0.5	0.4	0.8	0.8	0.5	0.3	0.2	0.1	0.4	0.6	0.4	0.2	0.4	35
23	Spain	2.3	2.0	1.7	2.0	0.8	1.2	0.6	0.6	0.8	1.2	0.7	0.6	1.6	34
24	Canada	4.0	3.6	1.5	1.8	0.9	1.0	0.4	0.6	0.9	1.1	0.7	0.8	1.3	34
25	Denmark	-	-	0.3	0.3	0.2	0.1	0.1	0.0	0.2	0.2	0.1	0.2	0.2	33
26	Sweden	0.5	0.5	0.5	0.6	0.3	0.3	0.1	0.2	0.3	0.4	0.3	0.2	0.3	32
27	Austria	0.8	0.7	0.5	0.7	0.3	0.3	0.1	0.2	0.5	0.5	0.3	0.3	0.3	32
28	Norway	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	27

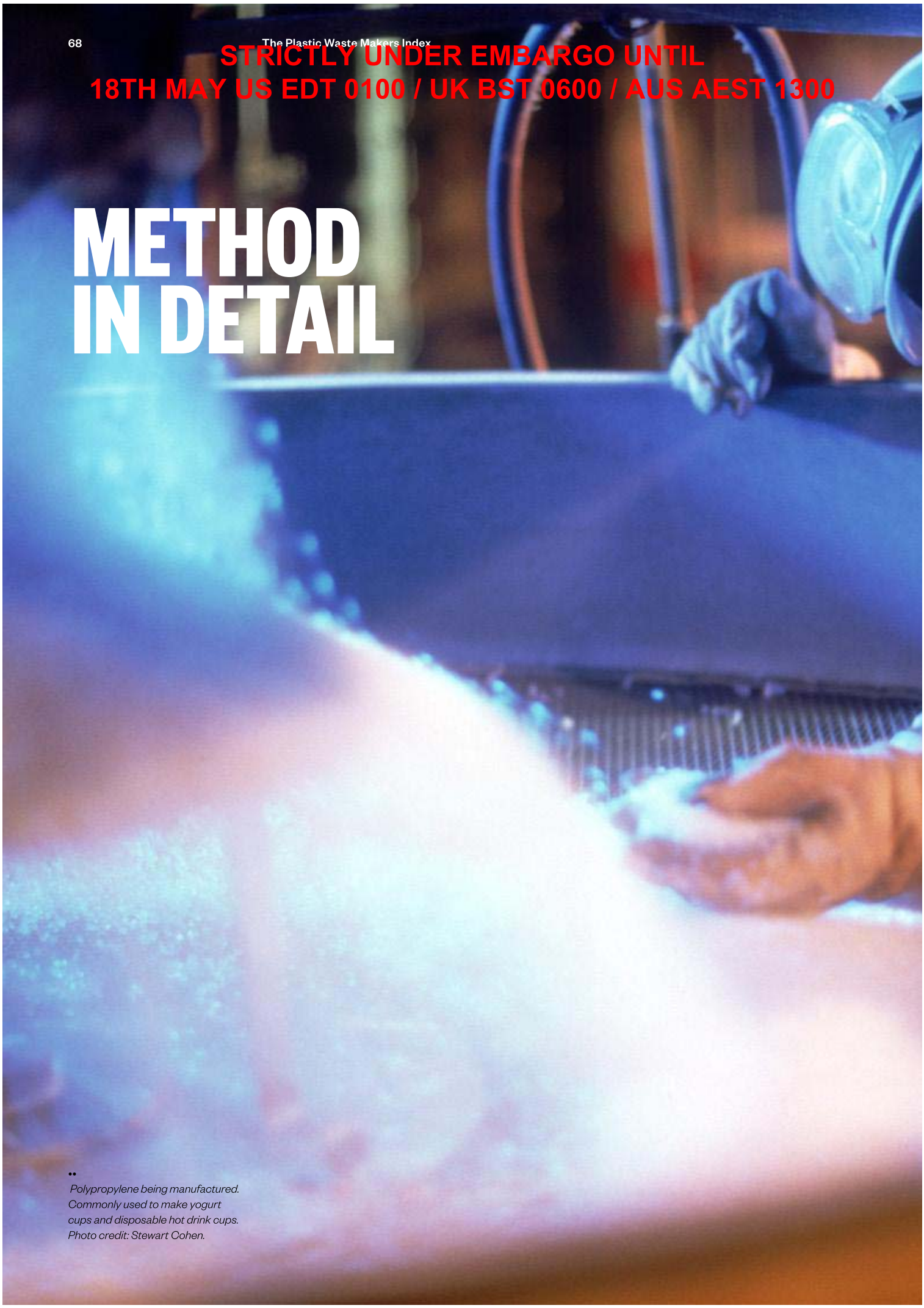
		In-scope Polymer Production and Trade				Conversion				Single-use plastic bulk packaging trade		Trade of single-use plastic finished goods		Single-use plastic waste generation	
Rank	Country	Domestic production (MMT) +	Exports (MMT) -	Imports (MMT) =	Net polymer production (MMT) -	Volume of out-of-scope application (MMT) =	Converted single-use plastic volume (MMT)			Bulk packaging trade (MMT)		Finished goods trade (MMT)		Net single-use plastic waste generation (MMT)	Single-use plastic waste generation per capita (kg per person)
							Total	Rigid format	Flexible format -	Exports +	Imports -	Exports +	Imports =		
29	Uruguay	-	-	0.1	0.1	0.0	0.1	0.1	0.0	-	0.0	-	-	0.1	25
30	Portugal	0.2	0.2	0.7	0.8	0.3	0.5	0.2	0.3	0.4	0.2	0.2	0.1	0.3	25
31	Italy	1.4	1.1	3.7	4.0	1.7	2.4	1.1	1.3	2.0	1.3	1.0	0.7	1.4	23
32	Poland	0.9	0.7	1.5	1.7	0.7	1.0	0.5	0.5	1.1	1.1	0.5	0.4	0.9	23
33	Greece	0.3	0.2	0.4	0.5	0.2	0.3	0.1	0.2	0.2	0.1	0.1	0.1	0.3	23
34	Costa Rica	-	-	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	-	-	0.1	23
35	Germany	5.1	4.3	3.7	4.4	2.1	2.3	1.3	1.0	3.4	3.3	2.2	1.8	1.8	22
36	Latvia	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0.0	0.0	0.0	22
37	Croatia	-	-	0.2	0.2	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	21
38	Slovakia	0.4	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.1	21
39	Lithuania	0.6	0.5	0.1	0.3	0.1	0.2	0.1	0.0	0.1	0.0	0.1	0.0	0.1	21
40	Hungary	0.7	0.5	0.3	0.5	0.2	0.2	0.2	0.1	0.3	0.2	0.1	0.2	0.2	20
41	Qatar	2.1	2.0	0.1	0.1	0.1	0.0	0.0	0.0	-	0.0	0.0	0.1	0.1	20
42	Vietnam	0.9	0.6	3.1	3.4	1.8	1.6	0.7	0.9	0.2	0.6	0.4	0.2	1.9	20
43	El Salvador	-	-	0.2	0.2	0.0	0.1	0.1	0.0	-	0.0	-	-	0.1	19
44	Thailand	7.0	4.3	0.9	3.6	1.7	1.9	0.7	1.1	0.9	0.5	0.4	0.2	1.3	18
45	China	51.4	3.6	20.9	68.8	34.2	34.5	11.5	23.1	7.9	1.2	3.9	1.5	25.4	18
46	Lebanon	-	-	0.1	0.1	0.1	0.1	0.0	0.0	-	0.0	0.0	0.0	0.1	17
47	Belarus	0.2	0.1	0.3	0.3	0.2	0.2	0.1	0.1	-	-	-	-	0.2	17
48	Mexico	2.5	1.0	2.5	4.0	1.7	2.3	1.2	1.1	1.5	1.4	0.5	0.6	2.2	17
49	Taiwan	3.7	2.7	0.6	1.6	0.6	0.9	0.4	0.5	0.9	0.3	-	-	0.4	17
50	Russian Federation	3.6	0.7	1.2	4.1	1.9	2.1	1.0	1.1	0.3	0.5	0.4	0.3	2.3	16
51	Malaysia	1.7	1.3	1.8	2.1	1.0	1.1	0.3	0.8	1.3	0.7	0.3	0.2	0.5	16
52	Trinidad and Tobago	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	-	-	0.0	15
53	Turkey	1.0	0.3	3.6	4.4	2.2	2.2	0.8	1.3	0.8	0.3	0.6	0.2	1.2	15
54	Peru	-	-	0.7	0.7	0.3	0.4	0.2	0.2	-	0.0	0.0	0.1	0.5	15
55	Romania	0.1	0.1	0.4	0.4	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.3	15
56	Panama	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	15
57	Argentina	1.0	0.4	0.5	1.1	0.5	0.6	0.3	0.3	-	0.0	0.0	0.1	0.7	15

		In-scope Polymer Production and Trade				Conversion				Single-use plastic bulk packaging trade		Trade of single-use plastic finished goods		Single-use plastic waste generation	
Rank	Country	Domestic production (MMT) +	Exports (MMT) -	Imports (MMT) =	Net polymer production (MMT) -	Volume of out-of-scope application (MMT) =	Converted single-use plastic volume (MMT)			Bulk packaging trade (MMT)		Finished goods trade (MMT)		Net single-use plastic waste generation (MMT)	Single-use plastic waste generation per capita (kg per person)
							Total	Rigid format	Flexible format -	Exports +	Imports -	Exports +	Imports =		
58	Brazil	4.9	1.4	1.4	4.9	2.2	2.7	1.0	1.6	0.2	0.2	0.1	0.2	2.8	13
59	South Africa	1.3	0.6	0.4	1.2	0.5	0.6	0.3	0.3	0.1	0.2	0.0	0.1	0.8	13
60	Iran	5.0	2.9	0.0	2.2	1.2	1.0	0.4	0.6	-	0.0	0.0	0.1	1.0	13
61	Georgia	-	-	0.1	0.1	0.0	0.0	0.0	0.0	-	-	-	-	0.0	12
62	Paraguay	-	-	0.1	0.1	0.0	0.1	0.1	0.0	-	0.0	-	-	0.1	12
63	Bahrain	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	-	-	0.0	12
64	Bulgaria	0.0	0.0	0.3	0.3	0.1	0.2	0.1	0.1	0.2	0.1	0.0	0.1	0.1	12
65	Serbia	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.1	-	-	-	-	0.1	12
66	Morocco	-	-	0.5	0.5	0.2	0.2	0.1	0.1	0.0	0.2	0.1	0.1	0.4	11
67	Cyprus	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	11
68	Colombia	0.5	0.3	0.7	0.9	0.5	0.5	0.2	0.3	0.1	0.1	0.0	0.1	0.5	11
69	Dominican Republic	-	-	0.2	0.2	0.1	0.1	0.1	0.0	0.0	0.0	-	-	0.1	10
70	Mauritius	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	10
71	Estonia	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	10
72	Ukraine	0.1	0.1	0.5	0.5	0.2	0.3	0.2	0.1	0.0	0.1	0.0	0.1	0.4	10
73	Philippines	0.6	0.1	0.6	1.1	0.6	0.5	0.2	0.3	0.1	0.5	0.1	0.2	1.0	9
74	Algeria	-	-	0.7	0.7	0.3	0.3	0.2	0.1	0.0	0.1	0.1	0.1	0.4	9
75	Tunisia	-	-	0.2	0.2	0.1	0.1	0.1	0.0	-	0.0	-	-	0.1	9
76	Egypt	1.3	0.8	1.2	1.7	0.8	0.9	0.3	0.6	0.2	0.2	0.0	0.1	0.9	9
77	Kazakhstan	0.0	0.0	0.2	0.3	0.2	0.1	0.1	0.0	-	-	0.0	0.1	0.2	9
78	Ecuador	-	-	0.3	0.3	0.1	0.1	0.1	0.1	-	0.0	-	-	0.1	9
79	Indonesia	1.9	0.4	2.6	4.1	1.8	2.3	0.9	1.4	0.4	0.5	0.3	0.2	2.3	9
80	Guatemala	-	-	0.3	0.3	0.1	0.1	0.1	0.1	-	-	-	-	0.1	8
81	Turkmenistan	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	-	-	-	-	0.0	8
82	Bosnia and Herzegovina	-	-	0.1	0.1	0.0	0.0	0.0	0.0	-	-	-	-	0.0	8
83	Iraq	-	-	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.3	7
84	Ghana	-	-	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.1	-	-	0.2	7
85	Jordan	-	-	0.2	0.2	0.1	0.1	0.0	0.0	-	-	-	-	0.1	7

		In-scope Polymer Production and Trade				Conversion				Single-use plastic bulk packaging trade		Trade of single-use plastic finished goods		Single-use plastic waste generation	
Rank	Country	Domestic production (MMT) +	Exports (MMT) -	Imports (MMT) =	Net polymer production (MMT) -	Volume of out-of-scope application (MMT) =	Converted single-use plastic volume (MMT)			Bulk packaging trade (MMT)		Finished goods trade (MMT)		Net single-use plastic waste generation (MMT)	Single-use plastic waste generation per capita (kg per person)
							Total	Rigid format	Flexible format -	Exports +	Imports -	Exports +	Imports =		
86	Libya	0.0	-	0.0	0.1	0.0	0.0	0.0	0.0	-	0.0	-	-	0.0	6
87	Azerbaijan	0.3	0.2	0.0	0.1	0.1	0.1	0.0	0.0	-	-	-	-	0.1	5
88	Honduras	-	-	0.1	0.1	0.0	0.1	0.0	0.0	-	0.0	-	-	0.1	5
89	Myanmar	-	-	0.4	0.4	0.2	0.2	0.1	0.1	0.0	0.1	0.0	0.0	0.3	5
90	Cambodia	-	-	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	-	-	0.1	5
91	Kenya	-	-	0.4	0.4	0.2	0.2	0.1	0.1	-	-	-	-	0.2	5
92	Uzbekistan	0.6	0.4	0.1	0.3	0.1	0.1	0.1	0.1	-	-	-	-	0.1	5
93	Mongolia	-	-	0.0	0.0	-	0.0	0.0	-	-	0.0	-	-	0.0	4
94	India	11.8	2.3	2.9	12.3	5.9	6.4	2.1	4.3	0.9	0.5	0.6	0.2	5.6	4
95	Cote d'Ivoire	-	-	0.2	0.2	0.1	0.1	0.0	0.1	-	-	-	-	0.1	4
96	Sri Lanka	-	-	0.1	0.1	0.1	0.1	0.0	0.0	-	0.0	-	-	0.1	4
97	Pakistan	0.4	0.2	1.1	1.3	0.6	0.7	0.3	0.4	0.0	0.1	0.1	0.1	0.7	4
98	Nigeria	0.5	0.1	0.6	1.1	0.5	0.5	0.2	0.3	0.0	0.1	0.0	0.1	0.7	4
99	Venezuela	0.2	-	0.0	0.2	0.1	0.1	0.0	0.1	-	0.0	-	-	0.1	3
100	Kyrgyzstan	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	3
	Togo	-	-	0.1	0.1	0.0	0.0	0.0	0.0	-	-	-	-	0.0	3
	Armenia	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	3
	Swaziland	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	3
	Yemen	-	-	0.1	0.1	0.0	0.0	0.0	0.0	-	0.1	-	-	0.1	3
	Cuba	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	3
	Kosovo	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	2
	Bolivia	-	-	0.1	0.1	0.1	0.0	0.0	0.0	-	-	-	-	0.0	2
	Albania	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	2
	Namibia	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	2
	Tanzania	-	-	0.2	0.2	0.1	0.1	0.1	0.0	-	-	-	-	0.1	2
	Nepal	-	-	0.1	0.1	0.1	0.1	0.0	0.0	-	-	-	-	0.1	2
	Bangladesh	-	-	0.8	0.8	0.5	0.3	0.0	0.3	0.0	0.1	0.1	0.1	0.3	2
	Mozambique	-	-	0.1	0.1	0.1	0.1	0.0	0.0	-	-	-	-	0.1	2
	Senegal	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	2
	Botswana	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	2

		In-scope Polymer Production and Trade				Conversion				Single-use plastic bulk packaging trade		Trade of single-use plastic finished goods		Single-use plastic waste generation	
Rank	Country	Domestic production (MMT) +	Exports (MMT) -	Imports (MMT) =	Net polymer production (MMT) -	Volume of out-of-scope application (MMT) =	Converted single-use plastic volume (MMT)			Bulk packaging trade (MMT)		Finished goods trade (MMT)		Net single-use plastic waste generation (MMT)	Single-use plastic waste generation per capita (kg per person)
							Total	Rigid format	Flexible format -	Exports +	Imports -	Exports +	Imports =		
	Laos	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	2
	Zambia	-	-	0.1	0.1	0.0	0.0	0.0	0.0	-	-	-	-	0.0	1
	Sudan	0.0	-	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	-	-	0.1	1
	Haiti	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	-	-	0.0	1
	Cameroon	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	-	-	0.0	1
	Syria	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	1
	Zimbabwe	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	1
	Angola	-	-	0.1	0.1	0.0	0.0	0.0	0.0	-	-	-	-	0.0	1
	Congo	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	1
	Jamaica	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	-	-	0.0	1
	Ethiopia	-	-	0.1	0.1	0.1	0.1	0.0	0.0	-	-	-	-	0.1	1
	Tajikistan	-	-	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	0.0	1
	Guinea	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	1
	Nicaragua	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	-	-	0.0	1
	Malawi	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	1
	Sierra Leone	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	1
	Uganda	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	0
	Afghanistan	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	0
	Madagascar	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	-	-	0.0	0
	Moldova	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-	-	0.0	0
	Liberia	-	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	-	-	0.0	0
	Benin	-	-	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	0.0	0
	Mauritania	-	-	0.0	0.0	0.0	0.0	0.0	-	-	-	-	-	0.0	0

METHOD IN DETAIL



Polypropylene being manufactured. Commonly used to make yogurt cups and disposable hot drink cups. Photo credit: Stewart Cohen.

In this section, we set out the methods and data sources used to address the following questions:

1. Who are the top 100 single-use plastic polymer producers, and how much single-use plastic waste do they ultimately generate, and where?
2. Who are the top 100 investors and banks funding single-use plastic polymer production?
3. How much progress have the top 100 polymer companies made towards circularity?

Further detail is included in the Basis of Preparation which can be found at www.minderoo.org/plastic-waste-makers-index/findings/methodology/.

QUESTION 1

Who are the top 100 single-use plastic polymer producers, and how much single-use plastic waste do they ultimately generate, and where?

Overview of method

We track the flow of single-use plastic materials through their lifecycle – from polymer form to finished goods to waste – and estimate where they are produced, converted, consumed and disposed. This generates an estimate of waste per producer and per country. A similar methodology was conceived by the US EPA in the 1970s (and in use ever since), but, to our knowledge, has never been applied on a global scale.[37] This "material flow" approach differs from previous attempts to estimate global plastic waste generation. Previous studies have modelled the mass of plastic in municipal solid waste (MSW-P) by combining country-level estimates of total waste generation and estimates of the share of plastic in total waste composition.

Data sources

Data on production mass by facility and polymer type, and data on country-level demand by conversion process and polymer type were provided by Wood Mackenzie; data on bills of lading for polymer exports were provided by ExportGenius; data on bilateral polymer trade and trade in bulk single-use plastic packaging are from UN Comtrade;[38] assumptions for trade intensity of single-use plastics in finished goods came from World Input Output Databases as analysed by McKinsey Global Institute;[39] and data on global trade flows of consumer goods came from World Integrated Trade Solution of the World Bank.

Single-use plastic material flow model

This analysis was completed between June and November 2020. For consistency and based on data availability, we used data for the calendar year 2019. Given single-use plastics are part of the "fast-moving" economy, we make the simplifying assumption that the total mass of polymers bound for single-use applications produced in the calendar year were – within the same calendar year – also traded, converted into packaging and products; traded as packaging and consumer products, traded as a constituent of finished goods, and disposed of. This is, by definition, a material flows model and not a stocks model. We therefore make no adjustments for existing stocks or build-up of inventory. Neither have we made any adjustments for material losses at different stages of production, trade and transformation.[40]

The analysis consisted of six modules (Figure M1).

Accumulation of plastic garbage in a canal leading to the Buriganga River in Dhaka, Bangladesh. The Buriganga river is known as one of the most polluted rivers in the country due to rampant dumping of industrial and human waste. Photo credit: Rehman Asad via Getty Images.

Figure M1

Our six-step approach to linking polymer producers to single-use plastic waste generation. MSW stands for Municipal Solid Waste.

	STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	STEP 6
MATERIAL FLOW	Polymer production	Polymer trade	Polymer conversion	Trade in single-use plastics in bulk	Trade of single-use plastics in finished goods	Single-use plastics MSW
KEY QUESTIONS	Who produces polymers that form single-use plastic, where and how much?	What are the trading patterns between polymer producers and countries?	How are polymers converted into single-use plastic product categories?	How are the relevant categories of bulk packaging traded?	What mass of single-use plastic in finished goods is traded and what are the trade patterns?	What is the mass of single-use plastic in municipal solid waste and what is its source?
KEY DATA SOURCE	**Wood Mackenzie**	**Export Genius** **UN Comtrade**	**Wood Mackenzie** **American Chemistry Council**	**UN Comtrade**	**McKinsey Global Institute** **World Bank World International Trade Solution**	**Result of this analysis**
IN-SCOPE MASS, million metric tons	~200	~90	~110	~40	~25	~110

STEP 1
POLYMER PRODUCTION

In-scope polymers

Single-use plastics can, in theory, be produced from over a dozen polymer families. However, in 2019, we estimate that close to 90 per cent of all single-use plastics by mass were produced from just five polymers: polypropylene (PP), high-density polyethylene (HDPE), low-density polyethylene (LDPE), linear low-density polyethylene (LLDPE), and polyethylene terephthalate resin (PET) (Figure M2).

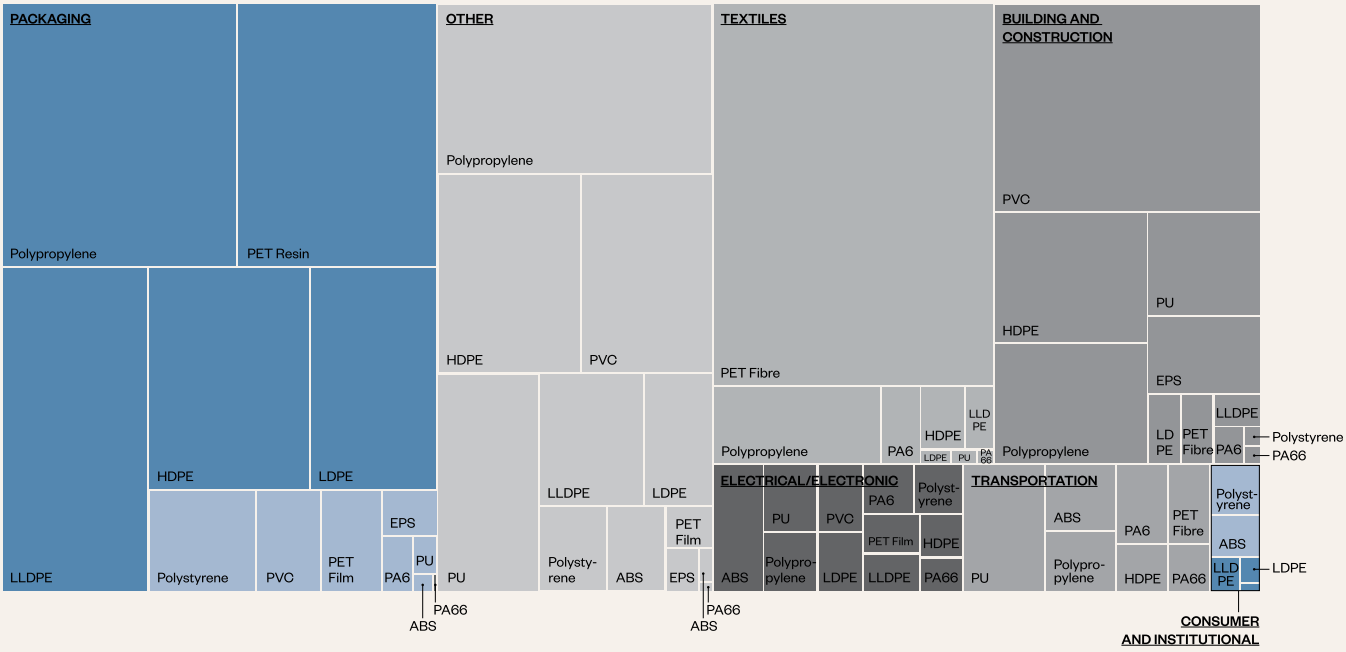
Production sources

We identified 1,205 production facilities globally, operated by approximately 300 individual petrochemical producers, producing just over 200 MMT of "in-scope polymers".

By tracking the transformation of single-use plastics from primary polymers, via conversion processes, into packaging and products, we could estimate the source of single-use plastic waste. We added analysis of where polymers are produced, by whom, and in what quantities, to provide estimates, not just of the source country of plastic polymer production, but also the source producer – i.e., specific petrochemical assets and their operators.

Figure M2

Overview of global plastic consumption by industrial sector, 2019. In-scope polymers and in-scope plastic categories



Scope *(Sector and polymer)*	Volumes *(million metric tons, 2019)*
Single-use plastics and in-scope polymer	110
+	
Single-use plastics and out of scope polymer	20
+	
Out of scope sectors, and polymers	246
All sectors and polymers	**= 376**

STEP 2
POLYMER TRADE

Close to half of global polymer output (90 MMT) was exported in 2019, with the trade intensity (exports as a share of production) of each polymer ranging from 38 per cent (for PET) to 67 per cent (for LDPE). We used trade data to estimate how the output of individual production facilities moved from the point of production to the point at which they were converted, under the assumption that material flows were segregated in transit.

Where the data was available, we used the bills of lading (used by customs to document trade) to track exports from specific facilities/companies to the country of import. Where company-level trade data was not available we used a "mass balance approach": we assumed that the exported mass from any individual production asset followed the weighted average for each polymer produced and exported in the country where the asset is located.

STEP 3
POLYMER CONVERSION

At the point of conversion – when source polymers are transformed into plastic products – we assumed that like-polymers from all source companies were mixed together. From this point onwards, we also adopted a mass balance approach to maintain a link between the source (of polymers) and the transformed materials as they flow to end-of-life. That is to say, for each production asset, whatever share of total material they account for at any specific node, an equivalent share of material flows forward to every subsequent node. In the absence of evidence to the contrary, perfect physical mixing of materials is assumed and a weighted average calculation applied to the output based on relative input mass.

In-scope applications

The single-use plastics category is defined as packaging applications and single-use consumer and institutional products (e.g., diapers, cotton buds): "in-scope applications".[41] How in-scope polymers are converted into in- or out-of-scope applications is estimated by matching individual polymers with the type of conversion process used. For example, when LDPE polymer goes through the process of extrusion coating, 100 per cent of this polymer is assumed to be converted into rigid single-use plastic packaging (in-scope application). As a counter-example, when LLDPE polymer goes through the process of rotomoulding, 100 per cent of this polymer of is assumed to be converted into non-single-use plastic products such as plastic tanks, buckets, bins, containers, toys, and outdoor recreational products and equipment (out-of-scope applications).

Estimates for the proportion of in-scope polymers converted into single-use plastics compared with other applications vary meaningfully by country. This variance is driven by the different mix of polymer types and the mix of demand from different conversion process facilities in each country. These same variables also drive differences in the mix of rigid versus flexible single-use plastic formats produced.

STEP 4
BULK SINGLE-USE PLASTIC PACKAGING TRADE

Single-use plastic packaging materials are either processed domestically into finished products (e.g., filled bottles, wrapped candies) or traded internationally in bulk. Traded packaging material includes rolls of film or foil, self-adhesive, laminated, or reinforced, but also sheets, caps, closures, lids and stoppers.

We estimated the mass of packaging traded in bulk and mapped the trade flows using open-access data from UN Comtrade. From the full list of six-digit Harmonised System trade codes (HS codes) and product descriptors, 16 HS codes were selected as representative of in-scope plastic packaging categories. These in-scope categories were further disaggregated based on their polymer composition and format (rigid or flexible). For each of these resulting product sub-categories, a country-to-country trade grid was built, covering more than 90 per cent of the traded mass. We again employed a mass-balance approach to maintain the link back to source polymer production assets.

STEP 5
TRADE OF SINGLE-USE PLASTIC IN FINISHED GOODS

As a proxy for the proportion of single-use plastics traded internationally (versus consumed domestically), we used estimates of trade intensity (gross exports as a percentage of gross output) from World Input Output Databases, as analysed by McKinsey Global Institute, for four industry value chains that use plastic packaging and products (Food and Beverage, Rubber and Plastic, Computers and Electronics, Furniture and Other Manufacturing).[42] We calculated a weighted average trade intensity across these four value chains by using estimates of total global trade for each from UN Comtrade. Making the assumption that the proportion of plastic packaging is consistent across every value chain, we calculated that 26 per cent of the total mass of single-use plastic in finished goods is traded internationally.

To model the bilateral trade flows of single-use plastic in finished products, we built a trade matrix using data from the World Bank's World Integrated Trade Solution using their Consumer Products trade category as a proxy for single-use plastics, calculating the share of total imports and exports for each country. We again employed a mass-balance approach to maintain the link back to source polymer production assets, and assumed a weighted average polymer composition for all traded masses.

STEP 6
ESTIMATES OF SINGLE-USE PLASTIC IN MUNICPAL SOLID WASTE

Finally, models 1-5 result in an estimate of every polymer producer's contribution to single-use plastic waste in every country, which we aggregate into company-level waste totals and country-level waste totals.

Confidence levels and uncertainties

Country-level estimates of material mass across production, polymer trade, conversion and packaging trade have high confidence levels: data sources are credible and triangulated, and calculation methodologies are proven. While confidence intervals have not been calculated, we expect these results to have a narrow margin of error. Assumptions used to estimated finished goods trade intensity have lower confidence and introduce more uncertainty about the final country-level single-use plastic waste estimates, especially for countries with relatively small populations (less than 10 million).

Confidence levels for estimates of individual polymer producers waste generation vary depending on the country of conversion and type of polymer. For example, we have high confidence that almost 100 per cent of PET resin production is converted into in-scope applications in any given country. However, for other polymers, the proportion being converted into in-scope applications varies – between 40 and 70 per cent – and we applied the weighted-average to every producer in the absence of any other evidence.

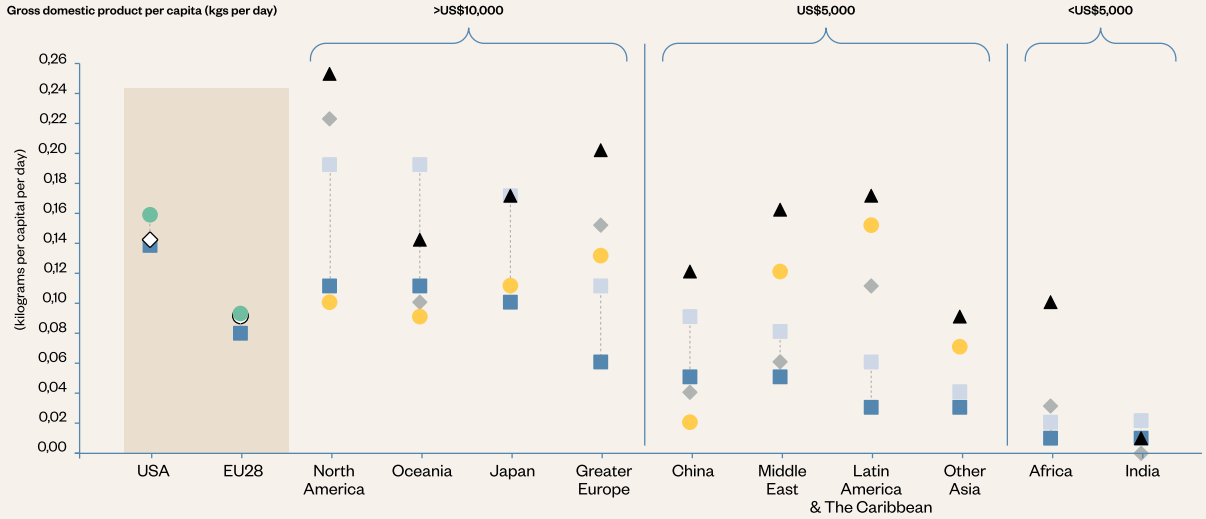
Comparison with previous studies

In Figure M3, we present country-level results of single-use plastic waste generation per capita from our analysis alongside existing estimates for the USA (from the US Environmental Protection Agency) and the EU (from Eurostat). For comparison, we show both the results of our analysis for in-scope polymers only, and also an adjusted number to reflect the greater contribution to single-use plastic waste from all polymers (+15 per cent).

We also present region-level results of generation of total plastic in municipal solid waste alongside estimates from three other notable studies: from the World Bank,[43] from the United Nations Environment Program,[44] and from Jambeck et al.[45] Again, for comparison, we show these regional estimates of single-use plastic waste and also an adjusted number that reflects the additional plastics contributing to municipal solid waste excluded from our analysis (but included in the others), namely, out-of-scope single-use plastic polymers (+15 per cent), and out-of-scope plastic applications, primarily textiles (+50 per cent). We grouped the regions according to gross domestic product per capita for ease of comparing plastic waste generation levels.

Figure M3

Triangulation of municipal solid waste (MSW-P) generation per capita vs. other studies.



- Results of our analysis
- Results of our analysis scaled up to include single-use plastics from all polymers
- Results of our analysis scaled up to estimate total plastic in MSW third
- Eurostat
- US Environmental Protection Agency
- United Nations Environment Program
- Jambeck Research Group
- World Bank

QUESTION 2

Who are the top 100 investors and banks funding single-use plastic polymer production?

The purpose of this analysis is to understand the financial flows associated with single-use plastic production.

Ownership analysis: equity holdings (in partnership with PlanetTracker)

Institutional asset managers (pension funds, mutual funds, insurance companies), sovereign states, as well as private individuals and institutions all own shares in companies (equity), making them part-owners of the company.

To identify who owns the largest 200 single-use plastic polymer producers identified in this report – who collectively account for more the 95 per cent of global production – we sourced shareholder data for public companies from Bloomberg and for private companies from Orbis.

Next, we estimated the value of the shareholders' equity. In almost all cases, production of polymers used for single-use plastics represents only part of a company's activities. We wanted to estimate only the value attributable to single-use plastic polymer production – versus other diversified businesses not directly related to generating single-use plastic waste. In general, diversified companies do not report results for business units that map perfectly to our definition used for this report (i.e., the production of the five in-scope single-use plastic polymers); and even where there is consistency at the reported level, there is no public market valuation of the relevant business unit.

To calculate the value of each shareholder's equity in single-use plastic polymer production, specifically, we estimated the relative value of the single-use plastic polymer production business – i.e., for every US$1 of equity value, we estimated what proportion was came from single-use plastic polymer production. For public companies, we estimated the share of total revenues coming from single-use plastic polymer production as a proxy for share of total market capitalisation. For private companies, we used a market cap-to-revenue multiplier based on the publicly-traded companies. For both public and private companies, we estimated revenue from single-use plastic polymer production by using average prices in 2019, by polymer, by region, sourced from SPGlobal.

Finally, we aggregated the value of the equity held by each shareholder across all public and private polymer producers and ranked them by estimated value.

Financing analysis: loans and underwriting (in partnership with Profundo)

To identify which banks are providing loans and underwriting facilities, we sourced data on the banking sector's financing of the top 50 single-use plastic polymer producers over a 10-year timeline, from January 2011 to December 2020, from Bloomberg, Refinitiv and IJGlobal.

The share of total attributed to an individual bank, for loan amounts syndicated or underwriting of shares or bonds facilitated, was estimated according to whether the bank was a "lead bookrunner" or "other participant", using a weighting calculation developed by Profundo.

To estimate the value specifically attributable to single-use plastic production, we adjusted the total value of all financing in the same way as described above for equity holdings.

Finally, loans and underwriting made by each bank to all single-use plastic polymer producers were aggregated, and banks were ranked by total estimated value of financing to the sector as a whole.

QUESTION 3

How much progress have the top 100 polymer companies made towards circularity?

It is important to understand whether and how companies are responding to the single-use plastic crisis. We therefore conducted an assessment of circularity to measure the extent to which the industry is adopting circular economy principles and practices.

In a circular economy, materials constantly flow around a 'closed loop' system, rather than in and out of a 'linear' system. In the case of plastic, this means simultaneously keeping the value of plastics in the economy, without leakage into the natural environment.

This analysis compared and ranked the efforts of the top 100 largest producers of single-use plastics in adopting circular economy principles with a view to encouraging greater commitment, engagement and progress from industry.

Materials and method: *Circulytics*

The Ellen MacArthur Foundation (EMF) recently concluded the pilot phase of a circularity assessment in the form of a voluntary survey: Circulytics. The pilot was tested during 2019 and a more extensive v2.0 of the survey started in October 2020, which reports in August 2021.

In recognition of EMF's extensive efforts, we have not attempted to re-invent a new methodology here. The exercise we conducted is complementary to EMF's survey – the difference being we have undertaken the assessment "outside-in", i.e., through desk-based research and analysing companies' public reports, rather than it being an internal assessment by companies themselves.

As a result, we have purposefully followed as closely as possible the Circulytics design for method, indicators, definitions and scoring, only adapting the survey for the limitations of a desk-based exercise and to be relevant to plastics producers.[47]

The Circulytics survey contains 50 questions that assess companies across two categories: Enablers (aspects that allow a company-wide transformation to happen) and Outcomes (evidence of circular business operations in practice). Across Enablers, questions are split into five sub-categories (Strategy and Planning, People and Skills, Operations, Innovation, and External Engagement). Across Outcomes, questions are split into six sub-categories (Products and Materials, Services, Plant, Property, and Equipment, Water, Energy, and Finance). We selected questions from each of the sub-categories that represent the range, but that could also be answered with publicly available sources.

Figure M4 presents the seven questions selected, along with the scoring for each question. Within Enablers, we included five questions from three sub-categories: two from Strategy and Planning; two from External Engagement; and one from Operations. Questions related to Innovation and People and Skills were omitted as we were unable to assess these outside-in. Within Outcomes, we included two questions on Products and Materials, which could be assessed "outside-in". Questions on the five other themes were omitted.

Figure M4

Questions and scoring for the Circularity Assessment

Questions based on Ellen MacArthur Foundation's Circulytics assessment				
ENABLERS	1	**Is your strategy aligned with becoming more circular?**		
		1.	No relevant mentions of circular economy	0%
		2.	Relevant concept (e.g. materials circulation, new business models that follow the principles of circular economy, not just resource efficiency) mentioned as part of strategic priorities	50%
		3.	Circular economy explicitly mentioned as part of strategic priorities	100%
	2	**Do you have measurable circular economy targets?**		
		1.	No targets	0%
		2.	Targets are being developed either for a relevant concept (e.g. materials circulation) or circular economy explicitly	25%
		3.	Targets developed on overall organisation level, but are not SMART targets	50%
		4.	SMART targets developed on organisation level	75%
		5.	SMART targets developed on organisation level and further down on sub-unit (e.g. business unit or region) level	100%
	3	**To what extent is suitable infrastructure in place to support a circular business model?**		
		1.	No plans in place to reconfigure existing or configure new infrastructure to support a circular business model	0%
		2.	Existing infrastructure is currently being reviewed to prepare the shift to a circular business model	25%
		3.	Existing infrastructure has been reviewed and/or new infrastructure are being designed to prepare the shift to a circular business model	50%
		4.	Reconfiguration of existing infrastructure or development of new infrastructure have started in order to support a circular business model	75%
		5.	All infrastructure is suitable for circular business models	100%
	4	**To what extent do you engage with suppliers to increase sourcing based on circular economy principles?**		
		1.	No interactions involving circular economy as a topic	0%
		2.	Ad-hoc interactions involving circular economy as a topic	20%
		3.	Ad-hoc interactions involving circular economy as a topic AND a plan in development for a programme using circular economy principles (e.g. codesigning material inputs for products designed along circular economy principles)	40%
		4.	Ongoing programme with one or more suppliers using circular economy principles	60%
		5.	Ongoing programme with one or more top 5 suppliers by mass (or by revenue when referring to services) using circular economy principles	80%
		6.	Supplier requirements based on circular economy principles, as specified in contracts, are in place with one or more of the top 5 suppliers by mass (or by revenue when referring to services)	100%
	5	**To what extent do you engage with customers on advancing circular economy topics?**		
		1.	No interactions involving circular economy as a topic	0%
		2.	Ad-hoc interactions involving circular economy as a topic	25%
		3.	Ad-hoc interactions involving circular economy as a topic AND a plan in development for an ongoing programme using circular economy principles (e.g. collaboration in communicating the benefits of products and services based on circular economy principles)	50%
		4.	Ongoing programme using circular economy principles with any customer	75%
		5.	Ongoing programme using circular economy principles with the majority of customers	100%
OUTCOMES	6	**For materials (renewable and non-renewable) suitable for the technical cycle, what per cent of your materials inflow (physical material that comes into your manufacturing processes) is:**		
		•Non-virgin (including reused and recycled products and materials)		0-100%
	7	**What per cent (by mass) of your total outflow of materials (renewable and non-renewable) suitable for the technical cycle is materials processing waste or by-products that go to landfill or incineration (and are therefore not recirculated)?**		0-100%

Scoring

For the five Enablers indicators, the scoring follows the Circulytics rubric. We used publicly available company information to arrive at scores, specifically: annual reports, sustainability reports and company websites. All three sources of company information were treated as having equal standing.

For the Outcomes indicators: company-level estimates of recycled PET feedstock inputs were provided by Wood Mackenzie (recycled inputs for other polymers were assumed to be negligible); for recycling rates of material outputs, we combined the waste estimates for each polymer producer (from the analysis of single-use plastic material flows described above) with country-level data on PET recycling rates from Wood Mackenzie and from publicly available sources for other in-scope polymers.[48, 49]

Data collection and scoring for the circularity assessment of the top 100 polymer producers were conducted by two teams in parallel, but independently: Minderoo and SYSTEMIQ. Sources and rationale for scoring were shared by both parties. Where there was significant variance in scores by the two teams, either a consensus was agreed, or the mid-point of the two scores was taken as the final score.

All questions were scored out of 100. The five Enablers scores were indexed to an overall score out of 50; and the two Outcomes scores were indexed to an overall score out of 50. Overall Enablers and Outcomes scores were added to provide a final score out of 100, equally weighting Enablers and Outcomes. Overall numerical scores were then translated to letter scores, as per the Table below. A score of 'A' implies a fully circular business model.

Table of numerical score to letter score translation

Lower Limit	Upper Limit	Letter
88.89	100	A
77.78	88.89	A-
66.67	77.78	B
55.56	66.67	B-
44.44	55.56	C
33.33	44.44	C-
22.22	33.33	D
11.11	22.22	D-
0	11.11	E

GLOSSARY

Rubbish pile in trash dump or landfill. Photo credit: Truong Phuong Tram via Getty Images.

Bio-based

Made from a renewable material (e.g., corn starch).

Bond

A fixed income financial instrument that represents a loan made by an investor to a borrower (typically corporate or policy-makers).

Circular economy

An economic system that reuses plastic resources, generating no waste.

Converters

In the context of the plastics supply chain, companies that process primary polymers into plastic applications (also referred to as the Plastic Containers and Packaging sector).

EMF

Ellen MacArthur Foundation.

Equity

The value of the shares issued by a company.

Feedstock

The raw material used to make plastic polymers.

GHG

Greenhouse gas, a type of gas that contributes to the greenhouse effect by absorbing infrared radiation (e.g. carbon dioxide, CO_2).

HDPE

High-density polyethylene, a type of plastic polymer.

Kg

Kilogram.

LDPE

Low-density polyethylene, a type of plastic polymer.

LLDPE

Linear low-density polyethylene, a type of plastic polymer.

Market capitalisation

The market value of a publicly traded company's outstanding shares.

MMT

Million metric tons.

MSW

Municipal solid waste, or everyday items discarded by the public. MSW-P is solid plastic waste, mainly single-use in nature.

PET

Polyethylene terephthalate, a type of plastic polymer.

PP

Polypropylene, a type of plastic polymer.

Recyclable

A post-consumer product that can be collected, sorted and recycled at scale and using proven technologies.

Recycling

Reprocessing of waste materials into products, materials, or substances, either for the original or another purpose, excluding energy recovery or fuel generation.

rPET

Recycled polyethylene terephthalate.

Underwriting

Banks provide underwriting services for loans, and equity and bond issuances, where they provide a guarantee that the required capital gets raised (e.g., by buying any remaining shares or bonds not issued). The institution takes on financial risk for a fee.

Virgin plastics

Plastic made from polymers that have been newly produced using fossil fuels such as natural gas or crude oil, rather than made from recycled polymer.

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