Planet Tracker

Novel Entities

A FINANCIAL TIME BOMB

Why investors need to be aware of the risks and impacts of toxic artificial chemicals

September 2024

CONTENTS

Authors: Christopher Baldock, Filippo Grassi, John Willis, Arianna Manili

This paper is part of Planet Tracker's planetary boundary series.
Please see Fixing Nitrogen for more information on the nitrogen planetary boundary

NOVEL ENTITIES

Novel entities are "new substances, new forms of existing substances, and modified life forms that have the potential for unwanted geophysical and/or biological effects." They include chemicals, plastics, other types of engineered materials or organisms not previously known to the Earth system, and naturally occurring elements (such as heavy metals) that are mobilized by human activities.[1]

PLANETARY BOUNDARIES

There are nine planetary boundaries which provide limits on humanity's production of certain types of pollution (such as carbon dioxide and chemical releases) and natural resource use (such as freshwater use). The boundaries are linked to global biophysical and biochemical processes that are known to regulate the state of the planet and maintain the stability that is conducive to human welfare and societal development.[2]

Novel Entities are one of the nine planetary boundaries.

Key Takeaways

Planetary boundaries delineate a safe space for humanity

- The planet has been largely stable for the last 10,000 years; but human actions have become a main driver of environmental change.[2]
- Nine planetary boundaries identify Earth-system processes and associated thresholds which, if crossed, could generate unacceptable environmental change.[3]
- Six of the nine planetary boundaries have been transgressed and a 7th is now close to the critical level, one of these being novel entities – i.e. the Earth is well outside a safe operating space for humanity.[a]
- Global production and consumption of novel entities continues to grow. Since 2016, a new substance has been registered in the Chemical Abstracts Service (CAS) database every 1.4 minutes.

The threat of untested novel entities

- Novel entities are synthetic chemicals and substances introduced by humans.
- There is a significant risk to not knowing or disclosing the toxicity of chemicals.
- In Europe and North America, over 350,000 chemicals and mixtures of chemicals have been registered for production and use.
- Surprisingly, most of these chemicals are untested. For the EU REACH regulation,[b] approximately 80% of these chemicals have been in use for at least 10 years without yet having undergone a safety assessment.

The financial risks from novel entities

- Novel entities can be viewed by the capital markets as representing innovation and technological development, providing valuation upside.
- However, novel entities can have impacts on human health, biodiversity, and on the processes that make Earth a safe and stable place to live.
- Perhaps of more immediate concern to corporates and financiers are the local impacts caused by novel entities on human and environmental health, which are not captured by planetary boundaries.
- Therefore, they can also be a source of significant litigation risk, in turn triggering profit warnings, asset sales and dividend cuts.
- These product releases should be priced into risk models. Near-term exposure (2022-30) to corporate liabilities from just plastic-related pollution – including chemical additives in the plastics – are likely to exceed USD 20 billion in the US alone.[4]

This paper includes case studies, which outline the importance of novel entities to financial institutions and why, and how, they need to act.

a Caesar L., Sakschewski, B. , Andersen, L. S., Beringer, T., Braun, J., Dennis, D., Gerten, D., Heilemann, A., Kaiser, J., Kitzmann, N.H., Loriani, S., Lucht, W., Ludescher, J., Martin, M., Mathesius, S., Paolucci, A., te Wierik, S., Rockström, J. (2024) Planetary Health Check Report 2024. Potsdam Institute for Climate Impact Research, Potsdam, Germany. Available here.

b REACH is an EU regulation on the registration, evaluation, authorization and restriction of chemicals. It is the main EU law to protect human health and the environment from the risks that can be posed by chemicals. Manufacturers and importers are required to gather information on the properties of their chemical substances and to register that information in a central database in the European Chemicals Agency (ECHA). See European Commission REACH Regulation here.

Executive Summary

Why Novel Entities?

- There are hundreds of thousands of novel entities – toxic substances created by humans and released into the environment that may be disruptive to the planet – travelling through the global economy.
- Novel entities are so ubiquitous because of their usefulness. However, how they are controlled, released and subsequently cause damage to environmental and human health is of global concern.
- There is relatively little knowledge of the impacts of novel entities, including synthetic organic pollutants, genetically modified organisms and micro and nano materials.
- Novel entities are a cross-sector problem which affect both the state of the environment as well as human health. However, most novel entities have not undergone safety assessments or information on those are protected or not shared.
- The precautionary principle [c] should be used to manage novel entities. Evaluating novel entities after they have been created and released is not acceptable.
- Novel entities need better regulation so that only those that are properly tested are used in commercial products and applications.
- There is undoubtedly a challenge in accessing data on the production and release of novel entities unless regulatory authorities are authorised to release this data publicly and ensure it is up to date.
- The challenge of estimating a planetary boundary for novel entities is therefore not only driven by the lack of emission data, but also by the scarcity of data on how these novel entities impact the environment.

Why are Novel Entities Relevant to Corporates, Lenders, and Investors?

- Novel entities are often viewed by investors and lenders as technological progress adding to revenue and earnings potential.
- Novel entities are a source of significant litigation risk.
- Novel entities produced decades ago can still cause significant financial downside to companies today and in the future.
- Exposure to litigation, and the reputational risk of being associated with toxic novel entities, have the potential to affect near and long-term valuation of companies producing and using them.
- International efforts to control novel entities need monitoring – for instance, see the Global Plastic Treaty – to ensure regulatory compliance.

c The precautionary principle is a term that carries legal weight that refers to "where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation... The precautionary principle reverses the burden of proof – the individual or entity proposing the activity must prove the activity is not harmful." See here for more details.

Introduction: Why Read this Paper?

What are novel entities?

Novel entities are "new substances, new forms of existing substances, and modified life forms that have the potential for unwanted geophysical and/or biological effects." They include chemicals, plastics, other types of engineered materials or organisms not previously known to the Earth system, and naturally occurring elements (such as heavy metals) that are mobilized by anthropogenic activities.[1] The focus of this paper is on the impacts of chemical and plastic production, use, and disposal.

How many novel entities are there?

A lot. The Chemical Abstracts Service (CAS) maintains a database of chemical names, CAS numbers, and structures for more than **204 million chemicals** disclosed in literature since the early 1800s.[5] Since 2016 **a new substance has been registered in the CAS database every 1.4 minutes**.[6]

Over 350,000 chemicals and mixtures of chemicals have been registered for production and use. This figure comes from an analysis of 22 chemical inventories that mainly cover North America and Europe. **Over 50,000 chemicals, 14% of the total, remain unknown as companies claim their composition as confidential**. Worryingly this excludes all South America, Africa, and large parts of Asia.[7] For context, over 26,600 substances were registered in the EU REACH database of which, 10,000 are yet to be assessed, and companies are only required to report releases of around 60 chemicals to the EU Pollutant Release and Transfer Register (E-PRTR).[8] [9] [10] In the US, the Toxic Substances Control Act (TSCA) Chemical Substance Inventory contains ~86,000 chemicals, and companies are required to report releases of nearly 800 chemicals across 33 chemical categories to the Toxics Release Inventory (TRI).[11] [12] On a company level, Saudi Basic Industries Corp (SABIC) alone releases 150 new products every year.[13]

Though we know a little about the release of chemicals to the environment in some regions, there is much that we do not know about many of their impacts.

Where are all these chemicals coming from?

According to the UN's Global Chemical Outlook II, **Asia was the largest chemical producing and consuming region and China had the largest chemical industry in 2017**. China had annual sales of EUR 1,293 billion, 37% of the global total. China experienced compound annual growth of 11.8% between 2000 and 2017. Global production capacity increased from 1.2 bn to 2.3 bn tonnes, with China representing 64% of the growth in that time.

The scale of chemical production is material. The industry accounts for approximately 10% of global energy demand, and 58% of this is consumed as feedstock. Figure 1 shows that the chemical industry used 1,700 million tonnes of feedstock and chemical reactants to manufacture 820 million tonnes of chemical products in 2015. For reference, the global capacity for bio-based polymers in 2016 reached 2.4 million tonnes, with 45% of this coming from Asia.[6]

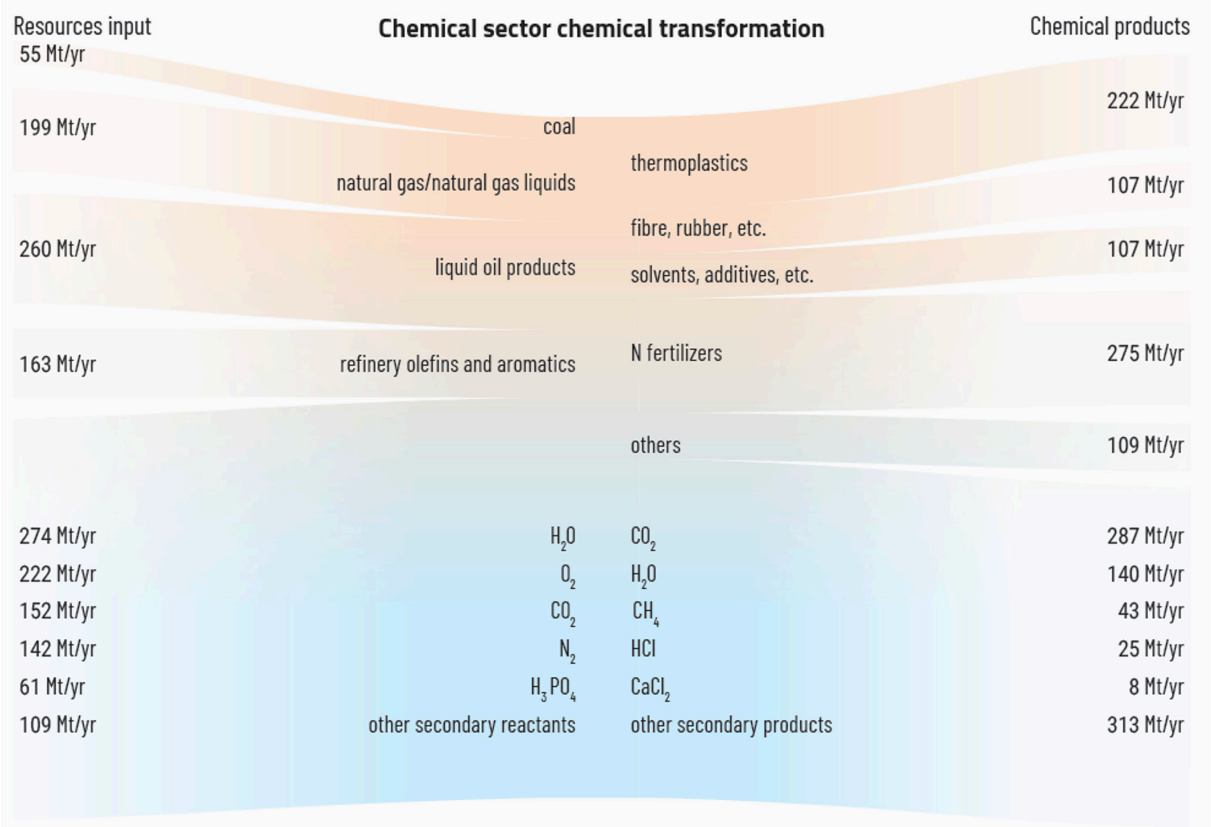


Figure 1: Resource extraction and chemical production by the chemicals sector. Source: UNEP[6]

What are the impacts of novel entities?

Novel entities can have impacts on human health, biodiversity, and on the processes that make Earth a safe and stable place to live. Planetary boundaries refer to the limits of pollution which we must stay below in order to maintain the status quo.[3] One example that readers will most likely be familiar with planetary boundaries, and the systemic style risks they aim to prevent, through their exposure to climate change and the limits imposed on greenhouse gas emissions.

Some chemicals can affect more than one planetary boundary. Chlorofluorocarbons (CFCs), for instance, can impact climate change, have ozone depleting effects, and be considered as novel entities.

Perhaps of more immediate concern to corporates and financiers are the local impacts caused by novel entities on human and environmental health, which are not captured by planetary boundaries. These can be more acute and are easier to link to the behaviour of individual entities. In such instances, such health impacts can become the basis of litigation cases against companies.

International efforts to control novel entities

There are four United Nations (UN) initiatives that investors should be aware of in relation to novel entities.

Adopted International Instruments

Adopted in September 1987, the **Montreal Protocol on Substances that Deplete the Ozone Layer** was a multilateral environmental agreement that regulates the production and consumption of nearly 100 man-made chemicals referred to as ozone depleting substances (ODS). The UN states that "the Protocol is to date one of the rare treaties to achieve universal ratification".[14] This treaty has evolved over time as new scientific evidence has emerged. For example, in September 2007, Member States agreed to the **Montreal Amendment** which accelerated the phase out of Hydrochlorofluorocarbons (HCFCs) and in October 2016 agreed to the **Kigali Amendment** which added hydrofluorocarbons (HFCs) to the list of controlled substances and their reduction by 80-85% by the late 2040s.[15]

The **Global Framework on Chemicals** is a plan to guide countries and stakeholders to address the waste and impacts of chemicals. It contains five strategies made-up of 28 targets and was adopted in Bonn in September 2023. The strategies include developing legal frameworks, ensuring data availability, prioritising issues of concern, developing safer alternatives, and mobilising finance.[16]

The framework originates from the Strategic Approach to International Chemicals Management (SAICM), which is a global multi-sectoral and multi-stakeholder policy framework, whose secretariat is hosted by UN Environment Programme. It offers a forum to discuss and address the many challenges related to the adoption and implementation of national policies to safely manage chemicals. While the SAICM mandate expired in 2020, gaps and challenges related to the production and use of chemicals still need to be addressed and should be taken on board by the actions under the Global Framework on Chemicals.[17]

To complement the Global Framework on Chemicals, it is worth highlighting other two international Conventions: the Stockholm and Rotterdam Convention, which both entered into force in 2004.

The **Stockholm Convention** is a global treaty to protect human health and the environment from chemicals that remain intact in the environment for long periods and requires government to take measures to eliminate or reduce the release of Persistent Organic Pollutants into the environments.[18]

The **Rotterdam Convention** represents another important instrument because it contributes to the environmentally sound use of those hazardous chemicals, by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties.[19]

Another important point for financiers is that 188 governments have adopted the **Global Biodiversity Framework**, a set of 23 targets that aim to protect and restore biodiversity.[d] Target 7 sets out two goals in relation to novel entities which should spur Governments and companies into action:[20]

i. Reduce the overall risk from pesticides and highly hazardous chemicals by at least half, and

ii. Prevent, reduce, and work towards eliminating plastic pollution.

Furthermore, the United Nation's **Sustainable Development Goal** (SDG) for responsible consumption and production specifically calls out chemicals in target 12.4. This calls for the responsible management of chemicals and waste, meaning that governments around the world need to significantly reduce their release to air, land and water. There are various international and national regulations in place that limit the use of hazardous substances, such as the Montreal Protocol, Stockholm Convention (mentioned above), OSPAR Convention, and various European Directives.

Work In Progress

The UN is also developing an international legally binding instrument on plastic pollution called the **Global Plastics Treaty**.[21] [22] [23] [24] [25] [26] Through a series of intergovernmental negotiating committees (INCs), Governments are developing an instrument which aims to address the impacts of plastics. The fifth round of negotiations (INC-5) are due to take place in South Korea in November 2024 and are expected to finalize the treaty text. In August 2024 an ad hoc intersessional open-ended expert group is expected to meet to identify and analyse criteria and non-criteria based approaches regarding plastic products and chemicals of concern in plastic products, among other things.[27] After this meeting it should be clearer how the international community will address the issues arising from chemicals of concern in plastic products.[28]

d Adopted in at the fifteenth meeting of the United Nations Conference of the Parties (COP15), the Global Biodiversity Framework contains 23 targets for 2030, and 4 goals for 2050 to protect biodiversity and reverse its loss.

Report Structure

Planet Tracker has provided six case studies which outline the importance of novel entities to financial institutions and why they need to act. There is also an introductory section on planetary boundaries and how novel entities fit into that framework, as well as Planet Tracker's investor statement, where signatories call on petrochemical companies to reduce their dependence on fossil fuel and eliminate hazardous chemical usage in plastic. Figure 2 provides a brief overview of the sections in this paper, while Figure 3 shows how the case studies are conceptually linked.

Figure 2: Planet Tracker novel entity report overview

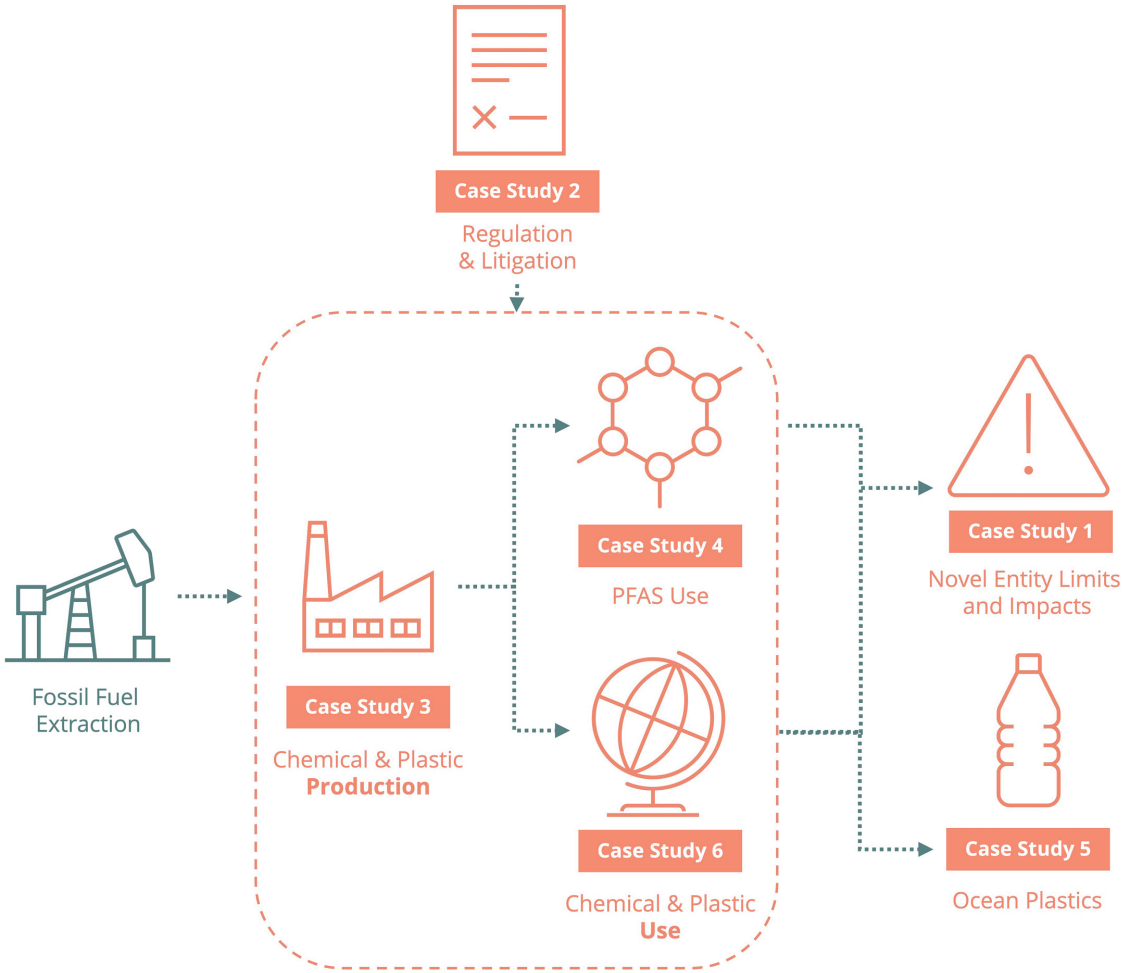


Figure 3: Planet Tracker case study linkages

Why Limit the Releases of Novel Entities?

Planetary Boundaries

As the flow of many pollutants emitted to air, land, and water exceeds the ability of the Earth to cope with them, their concentration steadily increases. There are limits for these pollutants, which if breached, could irreversibly change key Earth system processes on a planetary scale. The same applies to limiting the unsustainable consumption of freshwater, conversion of forests, and loss of biodiversity. These limits are called **planetary boundaries**.

The planetary boundary framework was popularised in 2009 by Johan Rockström and colleagues, and subsequently updated in 2015 by Will Steffen et al at the Stockholm Resilience Centre.[1] [3] Two smaller updates published in 2022 provided estimates for green water use (under the freshwater planetary boundary), and then for novel entities, including plastics.[9] [29] **A new paper was published in Science in September 2023 showing that six of the nine planetary boundaries have been exceeded.**[2] The nine planetary boundaries assessed include: atmospheric aerosol loading; biogeochemical flows; biosphere integrity; climate change; freshwater change; land-system change; novel entities; ocean acidification and; stratospheric ozone depletion. See Figure 4.

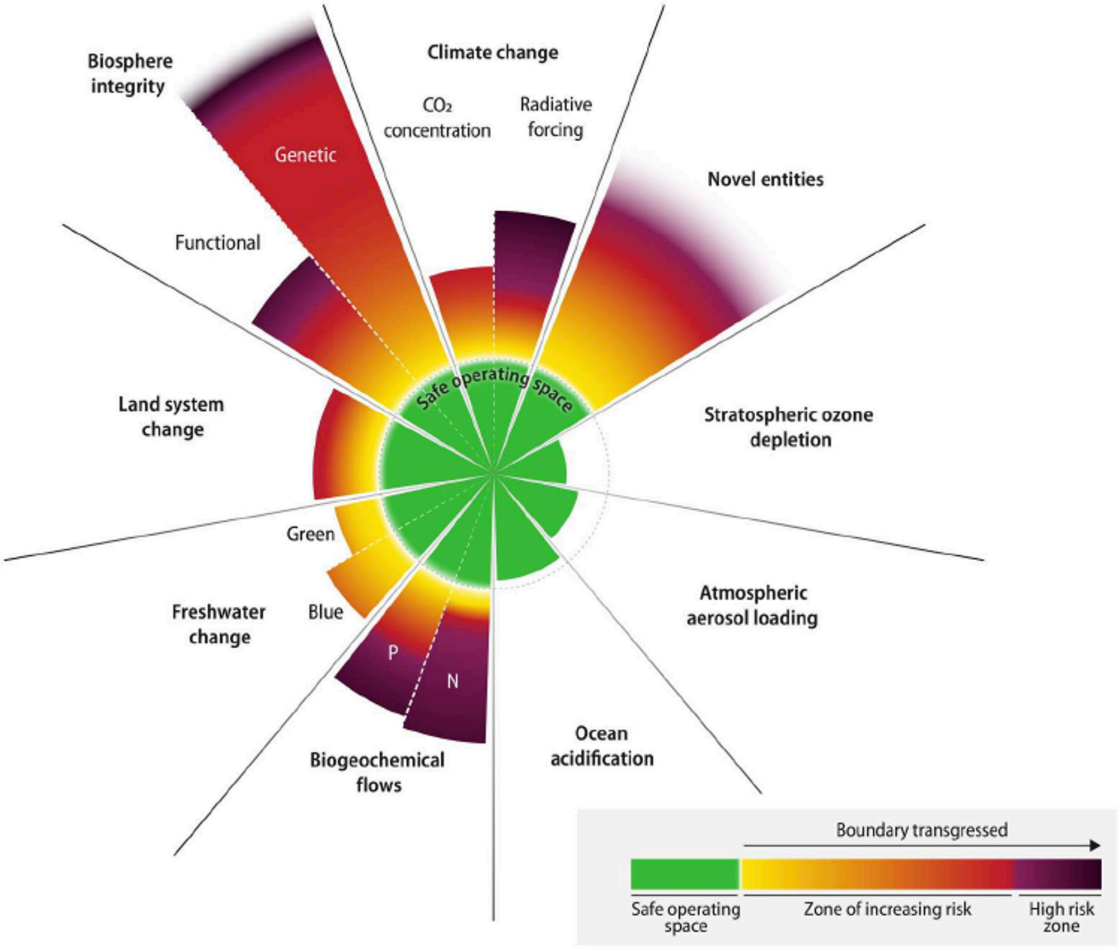


Figure 4: Current status of control variables for all nine planetary boundaries. First published in 2009 and last updated in 2023. Source: Stockholm Resilience Centre.[2]

Each of the planetary boundaries contains ranges to reflect the uncertainty around when a tipping point or threshold is exceeded - the point at which a new state in the Earth system is reached.[30] There is currently no range for individual novel entities, which is different for planetary boundaries like nitrogen, which is thought to be between 62 to 82 million tonnes per year.[e] Releases of novel entities are currently set by local, national, and international limits or bans on their use and/or release, normally based on their impact on human or environmental health.

Three categories communicate the current **performance** in relation to a planetary boundary. These are shown below, and the values provided are specific to nitrogen:

- **Safe**: below the planetary boundary
- **Uncertain**: between the lower and upper limits
- **Danger**: application in excess of the planetary boundary

We do not know by how much we are exceeding our novel entities planetary boundary

A complementary concept was proposed in 2012 which states that there is a certain amount of pollution that needs to occur in order for the basic needs of humanity to be met - **a social limit.** This notion, known as doughnut economics, can be viewed in the work of Kate Raworth.[31]

These needs should be met by staying below planetary boundaries so that global Earth system processes are not impacted, and that in the case of novel entities, enough goods can be produced to enable a good standard of living.[31]

e See Planet Tracker's Fixing Nitrogen report on why financial markets need to focus on nitrogen, which is critical for producing fertiliser and thus is a key input in the food system transformation.

The Importance of Novel Entities

Novel entities exist and continue to be produced and used at phenomenal rates due to their applications in everyday life. The Green Revolution of the 1960s was driven by the increasing use of synthetic fertilisers and pesticides. They are used in medical devices, as personal protective equipment, and for maintaining food hygiene. For example, certain per- and polyfluoroalkyl substances (PFAS) are excellent at resisting water, oil and heat, meaning they are used in a variety of applications from cookware to packaging and textiles. However, these chemicals can be accidentally released into the environment and can cause a variety of environmental and human health impacts which are briefly outlined in the sections below.

Biodiversity and Human Health Impacts

- Over 75% of leading global food crops are dependent on insect or animal pollination, but pollution from chemicals and waste is one of the key drivers of global biodiversity loss.[32]
- Two million lives and 53 million disability-adjusted life-years (DALYs) were lost in 2019 due to exposure to selected chemicals, with the main drivers of death being exposure to lead, and the occupational exposure to particulates and carcinogens.[33]
- Short- and long-term exposure to toxic chemicals can have chronic and acute health effects which can leave retailers and manufacturers liable for future costs.
- The health impacts of chemicals are not generally well-studied. Cases abound with chemicals that were considered safe and used for decades before their toxicity was discovered. PFAS, also known as "forever chemicals" as they are extremely difficult to breakdown, are a good example of this.

Climate Change and Greenhouse Gas Emissions

- Petrochemical plants are extremely energy intensive and the chemical industry accounts for ~10% of global energy demand. The emissions from which are dependent on the local energy mix, with coal being more important in countries like China.
- Several novel entities such as aluminium metal, fly ash particles, persistent organic pollutants and plastics have been identified as key indicators of the Anthropocene,[f] as shown in Case Study 5: Ocean Plastics.[34]

Financial Costs

- Environmental chemical exposure is estimated to inflict health costs that exceed 10% of global GDP.[35]
- The global chemical industry was estimated at around EUR 3.5 trillion by the UN. This translates to a huge investible universe which leaves financiers exposed to its share price fluctuations, bond performance, and financing conditions.
- The Minderoo Foundation estimated that the expected corporate liabilities from plastic litigation only, triggered in the period 2022-30 could exceed USD 20 billion in the US alone. These risks are concentrated "on specific sub-sectors of the plastic supply chain – principally on manufacturers of specific chemicals and primary polymers – magnifying their potential impact and the need for corrective action".[36] Note that plastic pollution not only includes micro- and nano-plastics, the ultimate destination of all plastic, but also toxic chemical additives.

f The current geological age where human activity has become the dominant force influencing the climate and environment.

- The publicly tradeable universe of chemical companies, according to the companies' GICS industry, is 1,959 companies with a combined market capitalisation of USD 3.0 tn. The top three countries, in terms of publicly traded companies, are China (524), India (316), and Japan (162). [37]

Feeding the World

- Pesticides, some of which contain PFAS, are heavily used in monocultures to control pests and protect food production, but they can also impact many other unintended targets.
- Genetically Modified Organisms (GMOs) – seen as a climate change adaptation measure, GMOs can be considered as novel entities as they receive novel traits from other species.
- Plastics are used frequently to transport food items, prolonging their shelf-life and preventing food waste, but they also cause impacts after their useful life due to poor design and waste management practices. UNEP's Global Waste Management Outlook estimated that "at least 2 billion people worldwide still lack access to solid waste collection".[38] Plastic waste often contains hazardous chemicals such as BPA, an endocrine disruptor which can contaminate food and drinks.[39] [40]

Transition

- Due to high capital costs of chemical infrastructure, the chemical sector is slow to transition as it is locked-in to technologies which cost millions to install and operate.
- However, the longer that these companies take to transition, the higher the risk from liabilities resulting from plastic pollution and chemical exposure.

Toxicity Debt

- There is a toxicity debt that we incur by having large amounts of chemicals which were emitted in the past, are currently degrading in the environment, but that have many more years of decay and release of toxic compounds to follow.[41]

These topics are discussed in more detail in the following six case studies. **The case studies reveal that measuring and managing novel entity limits is difficult.**

Petrochemical Investor Statement

In May 2024 Planet Tracker launched its petrochemical investor statement, whereby signatories call on petrochemical companies to reduce their fossil fuel dependence and eliminate hazardous chemicals in plastics. As of July 2024, USD 6.8 trillion of AUM, representing 73 investors, had signed the statement.[42]

Signatories support this statement as the burden imposed on society by plastics is significant, policymakers accelerate their efforts to address the growing pollution problem, and society, too, is gradually shifting their sentiment towards more sustainable products.

This poses significant plastic-related risks to petrochemical companies producing plastic polymers. These risks include regulatory risks (e.g., tighter emission controls, bans, taxation, and extended producer responsibility costs), reputational risks, plastic-related litigation, and increased consumer demand for safe and more sustainable products. These risks could be financially material for corporates and their funders.[43]

Signatories are concerned that petrochemical companies are not proactively addressing their plastic-related risks with actions aimed at reducing their dependence on fossil fuel feedstocks and eliminating hazardous chemicals from their products. As a result, they face higher costs and miss out on business opportunities, ultimately diminishing investment returns and long-term value creation. Signatories urge companies to act and align their business practices with a clearly defined transition plan to a safe and circular plastics economy, as outlined below.

Planet Tracker's expectations for accelerated corporate action on plastics

ASK 1

Transparently disclose, define strategies and set clear targets to transition to production of safe, environmentally sound and sustainable plastic

- Disclose to organisations such as CDP or TNFD
- Establish a timebound strategy to reduce fossil fuel feedstock
- Transition to the production of safe, environmentally sound and sustainable plastics

ASK 2

Address polymers and chemicals of concern in their products

- Commit to identifying and eliminating the use of hazardous chemicals and additives in polymers
- Publicly report their progress

ASK 3

Build sustainable infrastructure for production of sustainable materials

- Publish well-defined capital expenditure plans to develop technology and infrastructure to transition to the use of sustainable feedstocks

ASK 4

Establish dedicated governance

- Establish Board-level responsibility and oversight for achieving plastic sustainability commitments
- Link a share of management compensation to circularity commitments

ASK 5

Publicly support an ambitious international legally binding instrument for ending plastic pollution

- Advocate for common legally binding measures across the full plastics lifecycle designed to reduce plastic production and consumption, such as the Global Plastics Treaty and the Global Framework on Chemicals
- Refrain from lobbying and obstructing the ambitious outcomes aimed for in international plastic reduction efforts

This envisioned acceleration towards a circular plastics industry supports the UN Global Plastic Treaty goals, but is also in line with the Paris climate agreement and the Kunming Montreal Global Biodiversity Framework.

Novel Entities: Case Study 1

The Known Unknowns of Novel Entities

Issue

Once novel entities are released to air, land, or water we often know very little about how they behave or how they impact human and environmental health.

Relevance for Financiers

- Latent risks can surface decades after a product was commercialised and a toxic impact starts to manifest.
- There is a significant risk to not knowing or disclosing the toxicity of chemicals. Companies do not know what costs novel entities might create and when.

Case Study

What is known about novel entities?

Current environmental monitoring systems mostly measure the atmospheric and water concentration of a few hundred chemicals, but there are hundreds of thousands of chemicals that are not monitored, and whose toxic effects are little known, or not known at all. This is the "unknown unknowns" problem. Novel entities can affect the Earth system in many ways, most of which are not well understood. Assuming that the lack of evidence of harm means that harm does not exist is a logical fallacy because it incorrectly equates the absence of evidence with evidence of absence, ignoring the possibility that harm may simply not have been detected yet.

Ideally a planetary boundary would identify the specific impacts on the Earth system caused by specific chemicals. Unfortunately, due to the hundreds of thousands of chemicals in use this information is hard to come by and probably will not become available within a reasonable timeframe unless AI enables rapid and unforeseen progress. As such, all chemicals are currently grouped under the general container of the novel entities planetary boundary.

There is no single planetary boundary for novel entities due to the vast quantities, and mixtures of, chemicals in the Earth system. There are simply too many unknown variables, and therefore too many ways for companies to avoid responsibility for producing and using large quantities of toxic chemicals. The impacts of novel entities differ from carbon, which affects a more well-known planetary boundary, as a tonne of carbon emitted anywhere in the world is assumed as having an equal impact. Novel entities on the other hand are not all equal. Dioxins are extremely toxic in small quantities (grammes), whereas other compounds can be released in much larger quantities (tonnes) and still not have the same toxic effect.

Novel entities differ from carbon in two important aspects:

1. They have an unknown impact on planetary scale processes, and
2. Cause very localized impacts on human health and the environment.

This last point is perhaps more relevant to financiers as there has been a history of litigation against companies where a causal link can be found between the exposure to a particular substance and negative health outcomes, sometimes many years after they are first sold or emitted. Research has suggested that **up to 80% of chemical stocks are currently contained within products, compared to 20% that is contained within waste deposits and landfills**. This 80% includes products that still contain PCB, a chemical whose production was banned in the United States in 1976, and then internationally under the Stockholm Convention in 2001, which is still in-use in products today.[44]

How to measure a planetary boundary for novel entities

Measuring and monitoring a novel entity's planetary boundary is not straightforward. The factor that we measure (a control variable) should capture how Earth System processes change as humanity releases more and more novel entities into the environment each year. However, there are hundreds of thousands of novel entities, and we do not know how they impact these processes, nor do we know how most of them impact human or environmental health.

Attempts to quantify a planetary boundary have resulted in proposals to suggest that humanity's ability to conduct safety assessments versus the production and release of new chemicals could be used as a measure.[9] This however does not reflect a chemical's ability to impact Earth system processes, only the ability of society to regulate them properly. This approach would be appropriate to improve public understanding of chemicals and then inform the establishment of safe levels in the environment, but not on what levels would impact Earth system processes. Other suggestions are to:[9]

- Measure the release of plastics into the environment – estimates of plastic waste entering the ocean every year vary between 0.5 and 22.6 million tonnes.[9] [45] [46] [47] Note that plastics also contain chemical additives many of which are viewed as harmful to human health and the environment.[48]
- Quantify the "safe" level of chemical pollution – most of our understanding comes from a relatively small set of chemicals. For instance, 99.5% of the toxicity pressure from more than 12,000 chemicals found in over 22,000 European water bodies is explained by 15 compounds.[49] [g]
- Measure plastic disturbances to biosphere integrity, through the toxic effects of plastics causing changes in species distribution (mainly in the sea).
- Profile chemicals that are planetary boundary threats and control the production, distribution and/or use of these chemicals.[50]

g These 15 compounds are Bisphenol-A, N-1,3-Dimethylbutyl-N0-phenyl-pphenylenediamine, Chlorpyrifos, Anthracene, Octamethylcyclotetrasiloxane, N-(4-Aminophenyl)aniline, Cumene hydroperoxide, Difenylamine, 1-Dodecanol, Pyraclostrobin, Cyhexatin, p-Phenylenediamine, Dimoxystrobin, Terbufos, and Phorate.

Figure 5 shows a general **three-step pathway** for how novel entities are used and then released into the environment to impact human and environmental health, and then ultimately Earth system processes.

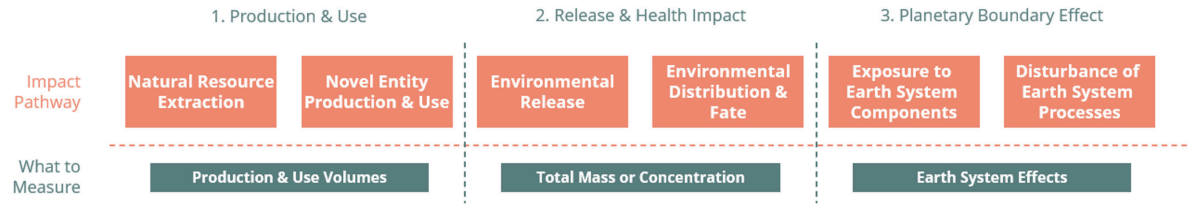


Figure 5: A general impact pathway for novel entities. Source: adapted from Persson et al., 2022.

As planetary boundary impacts are difficult to quantify for individual chemicals (Figure 5, step 3), we will focus our discussion on steps 1 and 2. This has the following benefits:

1. It is easier to link companies, and therefore the financing behind it, to novel entity production, use, and impacts.
2. There is more readily available information on the human and environmental health impacts of novel entities than there is for planetary boundaries.
3. Figures on chemical and plastic production, for instance, are easier to attain. Cumulative global production is projected to triple by 2050 to reach 33 billion tonnes.[9]
4. Governments collect and publish company-level data on novel entity production, safety assessments, and releases, for instance, the US TRI and the E-PRTR.

Toxic Footprints

Governments around the world have been collecting data on, and regulating, toxic releases for decades – see Case Study 2: Regulating and Litigating Against Novel Entities. A few studies have attempted to quantify the toxic footprints of nations and of individual companies.

One study calculated the human health and freshwater impact of 471 toxic chemicals released within 49 countries and regions around the world, finding that China ranked highest for both metrics.[h] See Table 1 for the ranking of European countries.[51]

h The authors of the study only provide data for 31 of the 49 countries/regions in order to make this calculation. Notable absentees from the data include the United States and Canada.

Table 1: Top 5 EU countries ranked by their annual national ecotoxicity and human toxicity footprint.[i] Source: Leclerc et al., 2023.[51]

Country	Rank – Ecotoxicity (trillion PDF m3 day)	Rank – Human Toxicity (million DALYs)
Russia	**1** (1,132)	**23** (0.57)
Germany	**2** (172)	**1** (25.65)
United Kingdom	**13** (61)	**4** (13.88)
France	**4** (53)	**2** (17.66)
Finland	**5** (43)	**29** (7.99)
Spain	**8** (32)	**3** (15.53)
Poland	**10** (25)	**5** (11.73)

Table 1 shows that toxic releases in Germany cause an estimated 25.65 million disability adjusted life years (DALYs), a measure of the disease burden of these chemicals on society. It should be noted that this does not include the potential impacts from chemical use in pesticides as well as the many thousands of chemicals lack toxicity information.

Planet Tracker has also analysed the toxic footprints of petrochemical companies in the US Gulf States, and in the EU Trilateral Region.[52] [53] Impacts in the US were measured in terms of their RSEI Hazard score – a US Environmental Protection Agency (EPA) produced metric for comparing sites - and in the EU toxicity was measured in terms of human and environmental toxicity, similar to that in Table 1.

One criticism of such data is that it identifies regional problems rather than a transboundary toxic footprint. However, where companies or states are adjacent, this can give rise to legal disputes. For example, the US EPA developed the 'Good Neighbor' plan' to address cross-state ozone pollution from upwind states. In June this year, the US Supreme Court temporarily blocked this regulation.[54] Two months later, the EPA announced how it intended to comply with the ruling.[55]

Toxic Fog

Even with large national or supranational databases there are significant grey areas. Reporting thresholds mean that companies only must report the use of chemicals over certain amounts. Some other disappointing aspects of national database on chemical releases are:

- Companies can hide their releases of toxic chemicals by claiming them as confidential, or a trade secret
- In the first two years of PFAS reporting to the TRI, only 40 disclosures were made across the whole of the United States
- There are only about 60 chemicals reported to the E-PRTR, compared to nearly 800 in the TRI
- Toxicity measures are not included with regulatory datasets, increasing the burden for third parties to make these assessments

i Planet Tracker chose regional characterization factors, and production output methods for both the disaggregation and extrapolation of chemical releases to calculate these values.

For a more detailed discussion of the limitations of the US TRI, please see Planet Tracker's report, Toxic Fog.

One study has found in a search of the CAplus database, which contains over 59 million chemical records, that 8.8% of chemicals reported in studies relate to only 10 chemicals. The top 500 chemicals correspond to 64% of the total chemicals found in the database. The authors state that this confirms "previous studies showing a significant bias toward repeated measurements of the same substances due to regulatory needs and the challenges of determining new, previously unmeasured, compounds."[56] This highlights that there remain significant gaps in our knowledge regarding the hundreds of thousands of chemicals currently in production and use around the world.

Actions for Financiers

For financiers to attain more information on companies' use and production of novel entities, financiers should demand from companies that they:

ASK 1

Transparently disclose, define strategies and set clear targets to reduce the impacts of plastics

- Disclose to organisations such as the CDP's plastic disclosure
- Establish a timebound strategy to reduce fossil fuel feedstock
- Transition to the production of safe, environmentally sound and sustainable plastics

ASK 2

Address polymers and chemicals of concern in their products

- Commit to identifying and eliminating the use of hazardous chemicals and additives in polymers
- Publicly report their progress

Further Reading

US Toxic Footprints report and data dashboards – a ranking of the most polluting petrochemical facilities in Texas and Louisianna, and the investors behind them

EU Toxic Footprint report and data dashboards - a ranking of the most polluting petrochemical facilities in Belgium, Germany, and the Netherlands and the investors behind them

Novel Entities: Case Study 2

Regulating and Litigating Against Novel Entities

Issue

Corporates are facing increasing scrutiny for their past and present use of dangerous chemicals, putting a range of products in the spotlight. Governments are banning and restricting the use of some chemicals, and litigation is emerging as an effective tool.

Relevance for Financiers

- The use of toxic chemical can cause financially material damages to companies
- Companies that have manufactured or sold these chemicals can become liable

Case Study

All Stick, No Carrot

A 2015 study identified 27 regulations or guidelines for controlling chemical releases and their impacts. Table 2 shows the **15 that are being applied at a global or a regional level**. The remaining 12 include Canada, China, India, Japan, Nigeria, and the United States.[44 j]

j Other initiatives include (i) Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989), (ii) Rotterdam Convention on the Prior and Informed Consent Procedure for Certain Hazardous Chemical and Pesticides in International Trade (1998), (iii) Minamata Convention on Mercury (2013)

Table 2: Global and regional approaches to controlling chemical releases. Source: Adapted from Diamond et al. (2015).

Geography	Category	Organisation Name & Limit Type	Scope
Global	Regulation	• United Nations Economic Commission for Europe (UN ECE) Convention on Long-range Transboundary Air Pollution (LRTAP) (1981) • Critical loads	• Environmental Health • Major air pollutants - SOx, NOx, VOCs,[k] ammonia, POPs, and heavy metals (cadmium, lead, and mercury)
		• Montreal Protocol (1989) • Reduction & Ban	• Environmental & Human Health • CFCs[l]
		• Stockholm Convention (2004) • Reduction & Ban	• Environmental & Human Health • POPs[m]
	Advisory	• World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO) (1961) • Acceptable Daily Intake	• Human Health • Food additives, veterinary pharmaceuticals and pesticide residues in food
		• Joint FAO/WHO Expert Committee on Food Additives (JECFA) (1961) • Tolerable Daily Intake	• Human Health • non-intentionally used xenobiotics in food
		• JEFCA (1961) • Provisional Tolerable Weekly Intake	• Human Health • non-intentionally used xenobiotics in food that may accumulate in the human body
		• Bonn Declaration / Global Framework on Chemicals (2023)	• Environment & Human Health • It promotes the sound management of chemicals and preventing harmful exposure to chemicals while phasing out the most dangerous substances
Europe	Regulation	• Regulation (EC) 396/2005 (2008) • Maximum Residue Levels	• Human Health • Pesticides in food
		• Regulation (EC) No 1107/2009 (2009) • Toxicity Exposure Ratio	• Environmental Health • Pesticides (active ingredients and formulated products)
		• Water Framework Directive (WFD), Directive 2000/60/EC (2000), Directive 2008/105/EC on Environmental Quality Standards, Directive on priority substances (2008/105/EC) (2008) • Environmental Quality Standards and Maximum Allowable Concentration	• Environmental Health • Priority pollutants detected in water bodies
		• Regulation EC 1907/2006 (REACH) (2006) • Predicted No Effect Concentration	• Environmental Health • Industrial chemicals in water, air, soil, sediment
		• Regulation EC 1907/2006 (REACH) (2006) • Derived No Effect Level	• Human Health • Industrial chemicals
		• Directive 2010/75/EU on Industrial Emissions & Integrated Pollution Prevention and Control (2010) • Emission Limit Values	• Environment & Human Health • Chemicals produced at a given site
	Advisory	• Guideline of the European Medicines Agency (EMA) on the environmental risk assessment of medicinal products for human use (EMEA/CHMP/SWP/4447/00) (2024) • Action Limits (thresholds that trigger further actions if exceeded)	• Environmental Health • Human pharmaceuticals
		• EMA Guideline on the limits of genotoxic impurities (EMEA/CHMP/ICH/83812/2013) (2013) • Threshold of Toxicological Concern	• Human Health • Genotoxic impurities in pharmaceuticals food contact materials
		• EU Chemical Strategy (2020)	• Environment & Human Health
		• EU Commission Restrictions Roadmap under the Chemicals Strategy for Sustainability (2022)	• Environment & Human Health
North-East Atlantic	Regulation	• The Convention for the Protection of the marine Environment of the North-East Atlantic (OSPAR Convention) (1998) • Reduction & Ban	• Environmental Health • Hazardous chemicals

k VOC: volatile organic compound

l CFC: chlorofluorocarbon

m POP: persistent organic pollutant, such as aldrin, dioxins, DDT, furans, and PCBs.

In order to comprehend the vast number of chemicals in use and released to the environment, **countries and supranational organisations have created chemical registries and reporting regimes. These can contain as little as 182 chemicals, such as in India's Inventory of Hazardous Chemicals, or over 145,000 chemicals as in the EU's REACH pre-registered substances database**.[57] [58] A list of 22 chemical registries from around the world can be found in Appendix 2: National and Regional Chemical Inventories.[7]

Regulating Risks and Hazards

In the EU, regulation focuses on hazards, a chemical's inherent properties, rather than risks, the possibility of harm arising from exposure. This focus on hazards is more precautionary and allows authorities to ban chemicals with problematic properties, such as PBT. This approach can even help to identify chemicals that are likely to planetary boundary threats based on their properties.

New regulation, preferably focussing on chemical hazards, can be effective in reducing the production and circulation of dangerous chemicals. For example, the European Chemicals Agency found that volumes of 59 substances of very high concern, which were subject to authorization under REACH, fell by 45% in the EU between 2010 and 2021. The production and import of five phthalates and trichloroethylene dropped by 90% in a decade, and production of chemicals that are carcinogenic, mutagenic and reprotoxic fell by 16%.[59]

Bisphenol A (BPA), an endocrine disruptor particularly dangerous for children, and used in food packaging since the 1960s, has seen increased scrutiny by the scientific community and regulators.[60] In the last decade, the US and Europe have started banning BPA in plastic bottles and packaging containing food for children.[61] In 2023 the European Food Safety Authority (EFSA), which had produced its first risk assessment on BPA back in 2006, reduced the tolerable daily intake of BPA by a factor of 20,000. This means that now consumers with average exposure to BPA in all age groups exceed the new tolerable daily intake.[61] Nevertheless, this new regulatory push is having an effect: many consumer brands started to offer BPA-free products, although there is concern for the lack of transparency on what BPA is being substituted with. There is a risk that substitute chemicals could pose similar health concerns.[62] [63]

Per- and polyfluoroalkyl substances (PFAS) are a subset of chemicals which are extremely persistent in the environment which are becoming increasingly regulated. The European Union has controlled or banned the use of certain PFAS for over ten years. Perfluorooctane sulfonic acid and its derivatives (PFOS), perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds, and perfluorohexanesulfonic acid (PFHxS) have all been included in the EU's POP regulation since 2013, 2020, and 2023 respectively. They are also included in the Stockholm Convention so that their use can be eliminated.[64] [65]

This pressure is already having some effects: a number of world leading companies[n] such as Apple, Patagonia and over 100 other companies have announced they are taking proactive steps to phase out PFAS.[66] [67] Case Study 4: PFAS and the Danger of Forever Chemicals on page 39 provides more details on these substances.

n See the ChemSec PFAS movement website here

Purchasing and Inheriting Risk

Litigation issues are typically not resolved quickly. BASF reported in 2021 that since August 2019 it had been named as a defendant in 638 suits relating to personal injuries and damages resulting from exposure to PFAS containing Aqueous Film Forming Foam that it had manufactured, distributed, and/or supplied. This was the result of its purchase in 2009 of Ciba Specialty Chemicals. BASF said at the time that *"To our current knowledge, none of these proceedings will have a material effect on the economic situation of BASF."* In 2022 it reported that the number of cases where it was defending itself had risen to 1,200. In 2023 it reported that this once again increased to 4,200 suits, but updated its outlook to say that *"An adverse outcome could be material to BASF's financial results."* [68] [69] [70] Planet Tracker has observed a similar pattern with other corporates where initially perceived legal cases are subsequently upgraded to material to investors.

One-Time Releases

Releases of toxic chemicals to the environment are not always controlled and foreseen events. **Chemicals can be released due to one-off events, either accidentally or deliberately, which cause abnormal amounts of toxic substances to be released to the environment**. Over 18,000 tonnes of toxic chemicals have been released because of one-off, non-production related activities, such as accidental releases and remedial actions, by petrochemical facilities in the United States since 2016. The biggest emitters are shown in Table 3.

Table 3: One-off and accidental toxic chemical releases from US petrochemical facilities since 2016 [71]

Rank	Company Name	Toxic Release (tonnes)
1	Chevron Corp	10,637
2	Solvay	901
3	Chevron Phillips Chemical Co	825
4	Indorama Ventures	431
5	MEGlobal	372
6	BASF	331
7	Hexion	286
8	Westlake Chemical	260
9	Lonza	231
10	TPC Group	187

The majority of Chevron's releases are of metal compounds (zinc, copper, nickel, and lead) which have a high environmental toxicity. Whereas 97% of Solvay's releases are of chlorobenzene, a possible carcinogen, and two-thirds of Indorama's releases are of asbestos, a highly toxic known carcinogen. Accidental releases should cause concern to financiers as they serve as both short- and long-term liabilities, especially if appropriate remedial actions or responsible business practices were not followed on-site.

Corporate Communication of Risks

The risks associated with plastic production and use is starting to be communicated publicly by large chemical companies. For instance, in its 2023 Annual Report, 10-K and 8-K submissions to the SEC, LyondellBasell disclosed the following risk factor for the first time, citing plastic and microplastic waste, the UN's Global Plastic Treaty, and the EU's Circular Economy Action Plan as drivers:

"...a host of single-use plastic bans and taxes have been passed by countries around the world and states and municipalities throughout the U.S. Consumer deselection, increased regulation of, or prohibition on, the manufacturing or use of plastic or plastic products could limit the use of these products or increase the costs incurred by our customers to use such products, and could lead to a decrease in demand for PE, PP, and other products we make. Such a decrease in demand could adversely affect our business, operating results, and financial condition." [72]

Bayer: A Leading Litigation Indicator

Bayer (BAY) is a leading company in crop science, pharmaceuticals, and consumer health. In the first quarter of 2024, the CEO presented his vision for the company.[73] He identified four major challenges of which litigation is viewed as 'top of the agenda'. Presently, Bayer produces 23 SIN List substances,[74] of which 13 are persistent (up from two persistent chemicals last year).

The company and its investors can observe how debilitating litigation can be. Free cashflow is being absorbed by ongoing litigation (EUR 13 billion in the last 5 years) and the legal cases are continuing. The dividend has been cut by 95% and strategic options, such as investing in growth areas, curtailed.[75] Chemical and petrochemical companies should take note and investors should be scrutinising the risk premium they require to fund these enterprises.

3M: Another Fine MMMess

Science and innovation multinational 3M reached agreement in 2023 to pay a present value amount of USD 10.3 billion in litigation fines over the next 13 years to 2036, resolving claims that PFAS had contaminated water supplies in the United States. The company will pay the money to any cities or counties across the country so they can test for, and clean-up, PFAS substances. The company, which plans to end its manufacture of PFAS by the end of 2025, will pay approximately 75% of the fine by the end of 2028, with payments of between USD 600 to 200 million being made each year to the end of 2036. 3M's website states that it "continues to actively engage in insurance recovery activities" due to the payment of these fines. This followed a similar settlement made by Chemours, DuPont, and Corteva with 300 drinking water providers to pay USD 1.9 billion in June 2023 that will be paid into a fund to remove PFAS from public drinking water systems.[76] [77] [78] [79]

Actions for Financiers

For financiers to reduce their exposure to company litigation linked to the use and production of novel entities, financiers should demand from companies that they:

ASK 1

Transparently disclose, define strategies and set clear targets to reduce the impacts of plastics

- Disclose to organisations such as the CDP's plastic disclosure
- Establish a timebound strategy to reduce fossil fuel feedstock
- Transition to the production of safe, environmentally sound and sustainable plastics

ASK 2

Address polymers and chemicals of concern in their products

- Commit to identifying and eliminating the use of hazardous chemicals and additives in polymers
- Publicly report their progress

ASK 3

Build sustainable infrastructure

- Publish well-defined capital expenditure plans to develop technology and infrastructure to transition to the use of sustainable feedstocks

ASK 4

Establish dedicated governance

- Establish Board-level responsibility and oversight for achieving plastic sustainability commitments
- Link a share of management compensation to circularity commitments

Further Reading

Is Bayer a litigation leading indicator? – the financial effect of litigation on Bayer and its investors

Novel Entities: Case Study 3

Chemical Production Outpaces Assessment Capacity

Issue

The chemical industry is growing rapidly, and so is the knowledge gap on the risk that chemicals pose to planetary health.

Relevance for Financiers

- Chemical production and trade is being increasingly driven by Asian economies, which traditionally provide fewer human and environmental health protections

Case Study

Producing Novel Entities

The top 3 producers of chemicals are China, the EU and the US. China produced EUR 1,729 bn worth of chemicals in 2021.[80] **China's Inventory of Existing Chemical Substances Produced and Imported contains over 45,000 chemicals**.[o 7] The EU (27) produced EUR 594 bn worth of chemicals in 2021.[81] Around 26,600 substances were registered in the EU REACH database, but **companies are only required to report releases of around 60 chemicals to the E-PRTR**. The US produced EUR 437 bn worth of chemicals in 2021.[82] The US EPA TSCA includes ~86,000 chemicals, but **companies are only required to report releases of 794 chemicals to the TRI**.[11 12]

The production of novel entities can be better understood by analysing the main economic sectors that produce them. This also helps in identifying the main companies relevant to financiers. The NAICS[p] Chemical Manufacturing sector (325) includes the following 4-digit industry groups, as show in Table 4

o Note this does not contain any information on toxic releases to the environment

p NAICS: North American Industry Classification System

Table 4: US Chemical Manufacturing Market. Source: NAICS Association.[83]		
NAICS Code	**Description**	**US Companies (#)** Share of Total Manufacturers (%)
3251	Basic Chemical Manufacturing	**8,152** 1.2%
3252	Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing	**3,503** 0.5%
3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	**2,217** 0.3%
3254	Pharmaceutical and Medicine Manufacturing	**13,120** 2.0%
3255	Paint, Coating, and Adhesive Manufacturing	**3,397** 0.5%
3256	Soap, Cleaning Compound, and Toilet Preparation Manufacturing	**9,38** 1.4%
3259	Other Chemical Product and Preparation Manufacturing	**4,674** 0.7%
		44,445 6.8%

Trading Novel Entities

In trade statistics, where goods are commonly classified according to HS[q] codes, chemicals generally fall into the following two sections in the 2022 HS version:

- **Section VI**: Products of the chemical or allied industries, which includes 923 6-digit HS products codes for items such as inorganic and organic compounds, pharmaceutical products, fertilisers, soap, cosmetics, paints, and explosives.
- **Section VII**: Plastics, rubber, articles thereof, which includes 211 6-digit HS product codes.

Global trade in products from these sections increased from USD 1.3 tn and 0.4 bn tonnes in 1995 to USD 3.9 tn and 1.2 bn tonnes in 2022.[r] See Figure 6.

q HS: Harmonised System

r USD values in 2022 equivalents

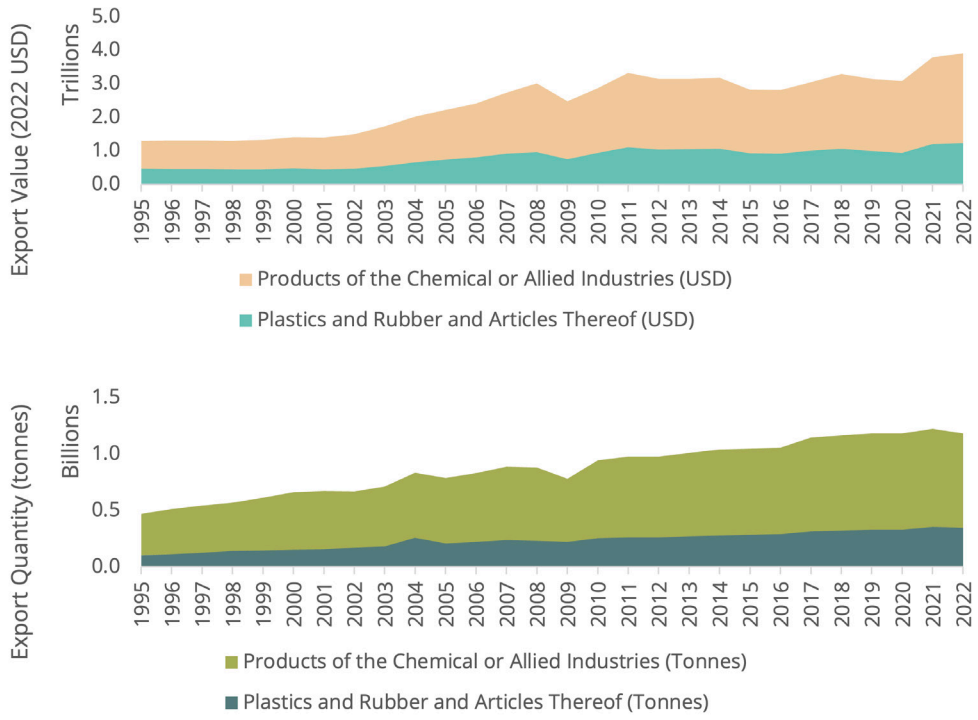


Figure 6: USD value and quantity of global trade of chemical goods by Harmonised System (HS) Chapter over time (1995-2022).

However, to identify industries and companies it is easier to use the NAICS classification. **There are 1,176 6-digit HS codes that can be mapped to the Chemical Manufacturing NAICS sector** (code 325), which in 2022 amounted to USD 3.6 tn in trade value globally, or 1.1 bn tonnes. Figure 7 shows the value and quantity of globally traded goods from chemical manufacturing sub-sectors in 2022.

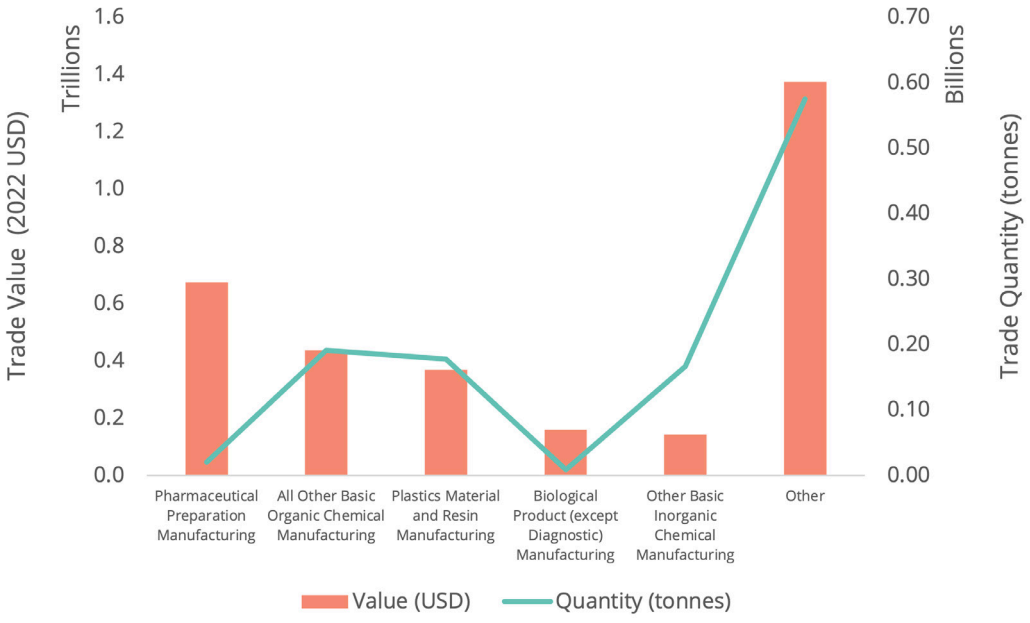


Figure 7: USD value and quantity of global trade of goods (2022) mapped to NAICS Sector 325, by subsector. Note that the sum of the individual bars does not give the total, since there is some double counting as one HS code can be mapped to multiple NAICS subsectors

Figure 8 shows the regions that export the most goods produced by the Chemical Manufacturing sector. Europe and Central Asia lead with USD 1.9 tn, followed by East Asia & Pacific (USD 1 tn) and North America (USD 0.5 tn). At a country-level most manufactured chemical goods are exported by China (499 bn), the USA (403 bn) and Germany (393 bn).

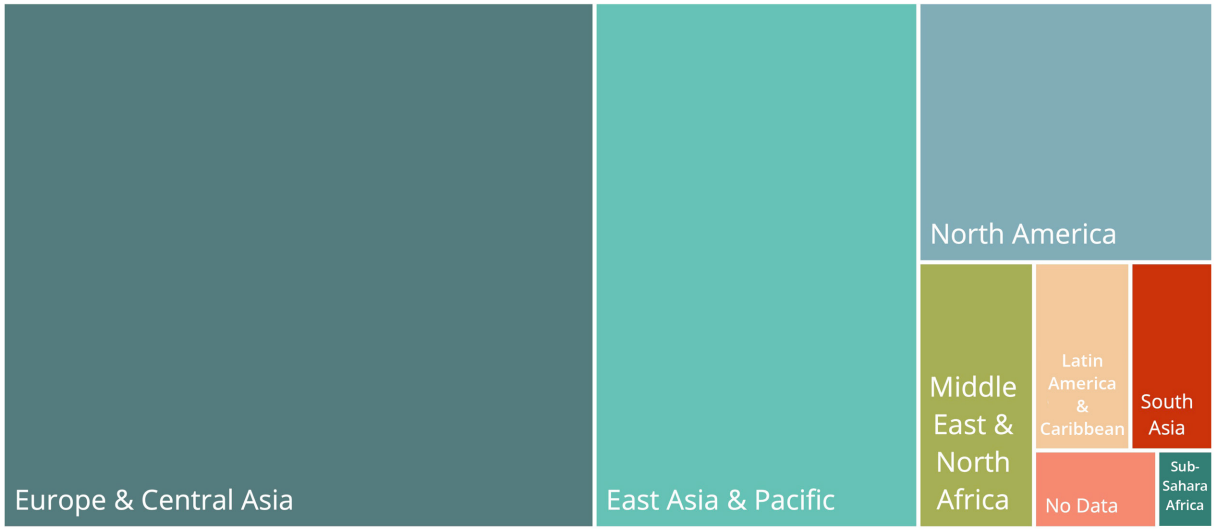


Figure 8: Exports of goods mapped to NAICS Sector 325, by region and country, for the year 2022.

Assessing and Approving Novel Entities

National and international legislation comes into play when assessing safety and regulating the safe use of novel entities introduced to markets. **However, standards and processes vary widely between countries and industries**.

For example, **the approval process for bringing new chemicals to market under EU REACH is much simpler than for pharmaceuticals**. The EU REACH programme does not require extensive clinical trials or post-market surveillance like pharmaceuticals, and the safety evaluation is based on available data.

On average, **it takes around 10 to 15 years for a new medicine to go from initial discovery to market launch**, and only one to two of every 10,000 compounds created in labs will successfully pass through all the stages of development necessary to become an authorized marketable medicine. The process involves multiple stages including exploratory discovery, preclinical development, clinical trials, regulatory submission and approval. Once approved, post-market monitoring continues to gather safety data on the drug's use in the general population.[84]

We can compare that with the approval process required to market a new pesticide containing PFAS - sulfoxaflor. Dow AgroSciences applied to the EU in September 2011 for the approval of sulfoxaflor and a draft assessment was produced in November 2012, which requested the applicant to supply additional information. The assessment of the additional information was submitted in January 2014, and in July 2015 the EU Commission approved the use of sulfoxaflor.[85] Since sulfoxaflor had similar properties as other already banned neonicotinoid insecticides, its approval was controversial, and civil society organizations protested. After further studies, in 2022 the EU Commission decided to ban sulfoxaflor due to concerns about its toxicity to bees.[86]

This does not mean that the pharmaceutical industry does not pose a global threat to environmental and human health. One study found that river pollution from active pharmaceutical ingredients was above safety limits for aquatic organisms in 25% of the 1,000 sites assessed across 104 countries.[87] This reflects a more general problem, that once novel entities are approved, it is often difficult to track how they travel through the environment and what toxic effects they cause down the line. Environmental monitoring projects usually focus on a few well-known hazardous chemicals, which means that the presence of novel entities in the environment is systematically understudied. This bias towards the knowns of the past means we are failing at identifying risks posed by novel entities, as the next case study on PFAS shows.[88] [89]

There is a possibility that technological advances such as machine learning and AI will help in screening novel entities and prioritise lab testing. For example, these methods could help us model the toxicity of thousands of unknown chemicals based on similar known chemicals.[90] The European Commission has also committed to grouping chemicals for risk management, rather than regulating them one-by-one, to expedite protection.[91] However, more is needed to solve the problem of chemical production outpacing assessment capacity.

Actions for Financiers

For financiers to attain more information on the technologies and infrastructure companies' utilise to produce novel entities, and to support a sustainable transition, financiers should demand from companies that they:

ASK 3

Build sustainable infrastructure

- Publish well-defined capital expenditure plans to develop technology and infrastructure to transition to the use of sustainable feedstocks

ASK 4

Establish dedicated governance

- Establish Board-level responsibility and oversight for achieving plastic sustainability commitments
- Link a share of management compensation to circularity commitments

ASK 5

Publicly support an ambitious international legally binding instrument for ending plastic pollution

- Advocate for common legally binding measures across the full plastics lifecycle designed to reduce plastic production and consumption, such as the Global Plastics Treaty and the Global Framework on Chemicals
- Refrain from lobbying and obstructing the ambitious outcomes aimed for in international plastic reduction efforts

Further Reading

Tomorrow's Chemistry: a comparative analysis of the Climate Transition Assessments of seven leading chemical companies

Novel Entities: Case Study 4

PFAS and the Danger of Forever Chemicals

Issue

PFAS are a group of chemicals that do not breakdown in the environment, hence their nickname – Forever Chemicals. They are very useful in industrial and commercial products but can have severe and long-lasting human and environmental health impacts.

Relevance for Financiers

- Companies can face litigation costs years after ceasing to use PFAS
- PFAS are integral parts of many products which could mean these products can come with long-term liabilities

Example: PFAS use can lead to litigation years after its use

- Solvay, a Belgian chemical company, and its partners used and manufactured PFAS at its West Deptford Plant, New Jersey for over 30 years. After Solvay ceased the use of PFAS at the site by 2013, it was ordered to pay USD 180 mn to remediate the damages caused by it escaping into the environment. There are still 35 private cases ongoing against the company.

Case Study

P-What?

Per- and polyfluoroalkyl substances (PFAS) have been defined by the OECD as:

"...fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it), i.e. with a few noted exceptions, any chemical with at least a perfluorinated methyl group (–CF3) or a perfluorinated methylene group (–CF2–) is a PFAS." [92]

Some common PFAS and their chemical structures are shown in Figure 9.

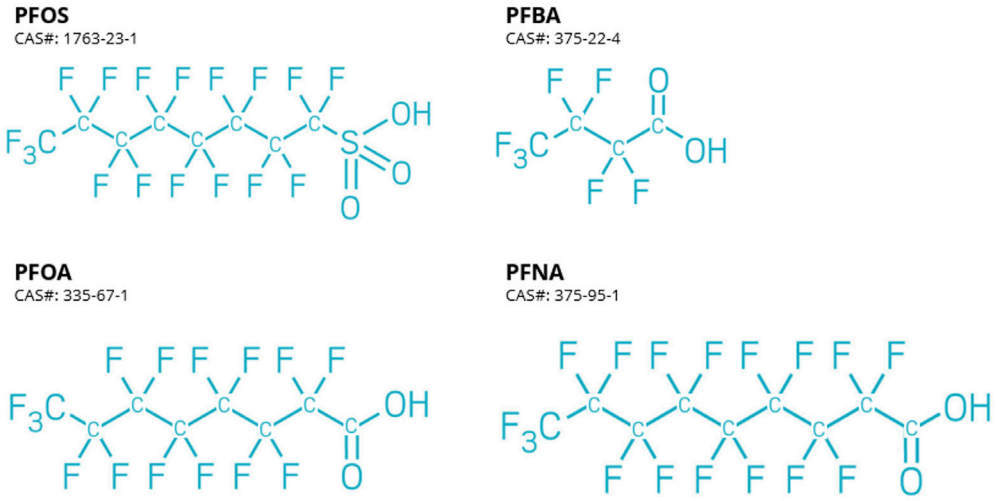


Figure 9: Some common PFAS and their chemical structures. Source: adapted from C&EN.[93]

PFAS have been in production for more than 70 years. Some PFAS such as perfluoroalkyl carboxylic (PFCAs) and perfluoroalkanesulfonic (PFSAs) acids have known health impacts, but most PFAS are poorly characterized, and have unknown toxicological impacts.

There are a total of 16,000 PFAS with known and unknown chemical structures in the US TSCA Inventory which have been used in over 200 areas, ranging from mining, food production and preparation, textile manufacturing, to firefighting foams.[94] [95] An estimated 122,500 tonnes of perfluorooctane sulfonyl fluoride (POSF), which degrades to perfluorooctane sulfonate (PFOS) in the environment, was produced worldwide between 1970 and 2002, with approximately 45,000 tonnes being released to air and water from its manufacture and use. 3M stopped manufacturing PSOF in 2002 due concerns surrounding impact on human and environmental health.[96]

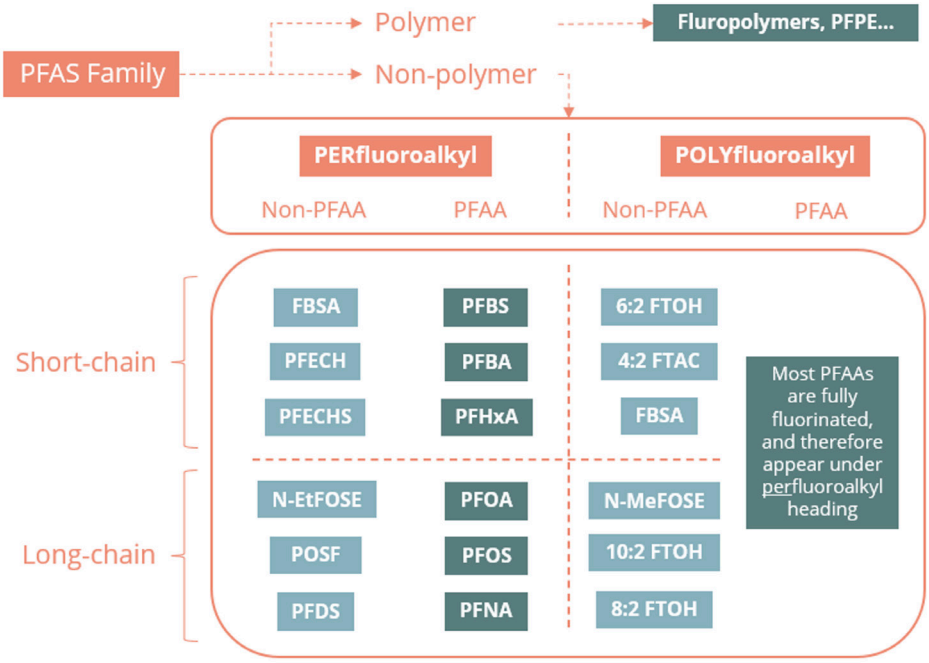


Figure 10: The simplified sub-set of the PFAS family of chemicals and how they can be distinguished. Please see the OECD report, Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendation and Practical Guidance, here, for a more comprehensive view.

PFAS Exposure is Unavoidable

PFAA (perfluoroalkyl acids), a subset of chemicals in the PFAS group, have been the subject of much study due to their impacts on human health and the environment. Due to the extreme environmental persistence of PFAS they are being found in more remote places. One study identified their presence in artic sea ice and meltwater, showing that PFAS can be transported and deposited over long distances, and potentially impacting remote parts of the marine food web.[97]

A review of 220 peer-reviewed scientific studies by Environmental Working Group (EWG), a US non-profit, found PFAS in over 600 species, ranging from Canadian reindeer to Atlantic cod, rockhopper penguins, and Chinese bullfrogs.[98] Figure 11 shows the full distribution of the species contaminated with PFAS from this relatively small number of studies.

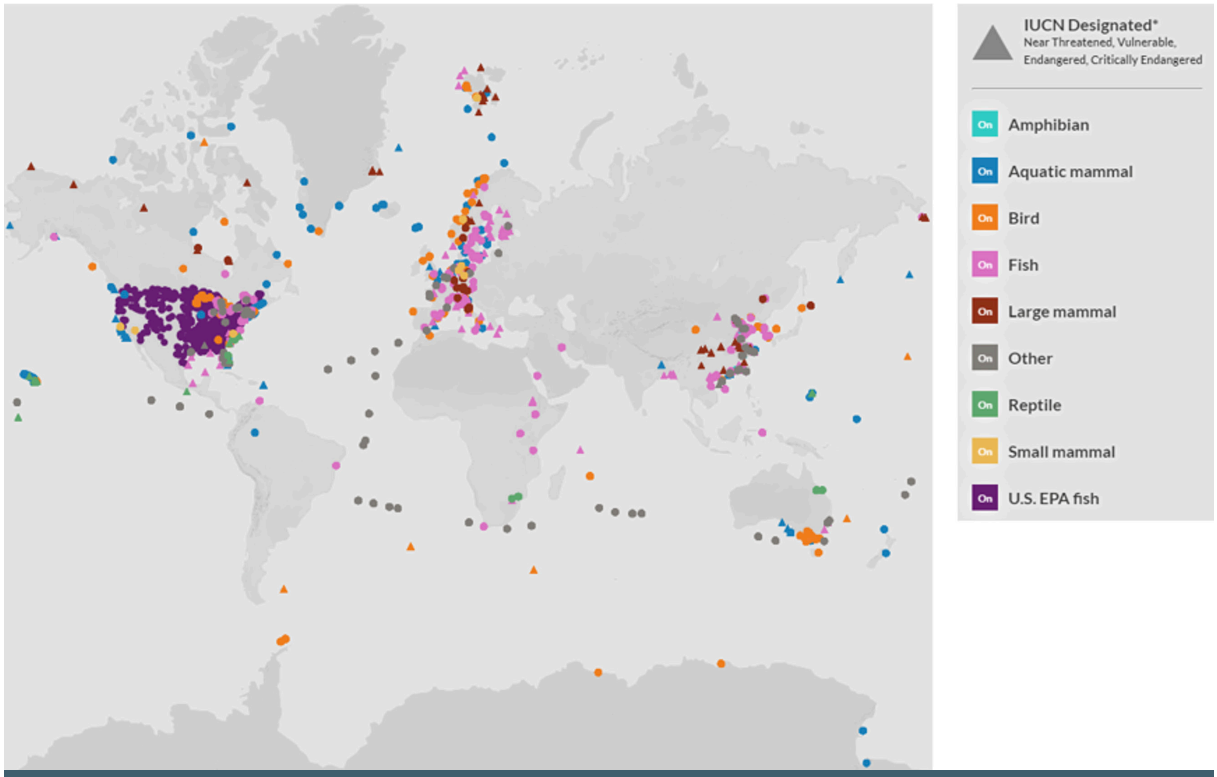


Figure 11: Wildlife at risk from PFAS exposure (Source: EWG)[94]

French newspaper Le Monde and 17 partners have produced a similar map **cataloguing PFAS contamination around Europe. The analysis includes 20 PFAS producers, 232 PFAS users, and 23,000 sites where PFAS contamination has been detected**. Figure 12 shows points of known contamination. There are many thousands of points where contamination is presumed to be which can be viewed on the map.[99] Note that releases of PFAS are not disclosed to the E-PRTR.

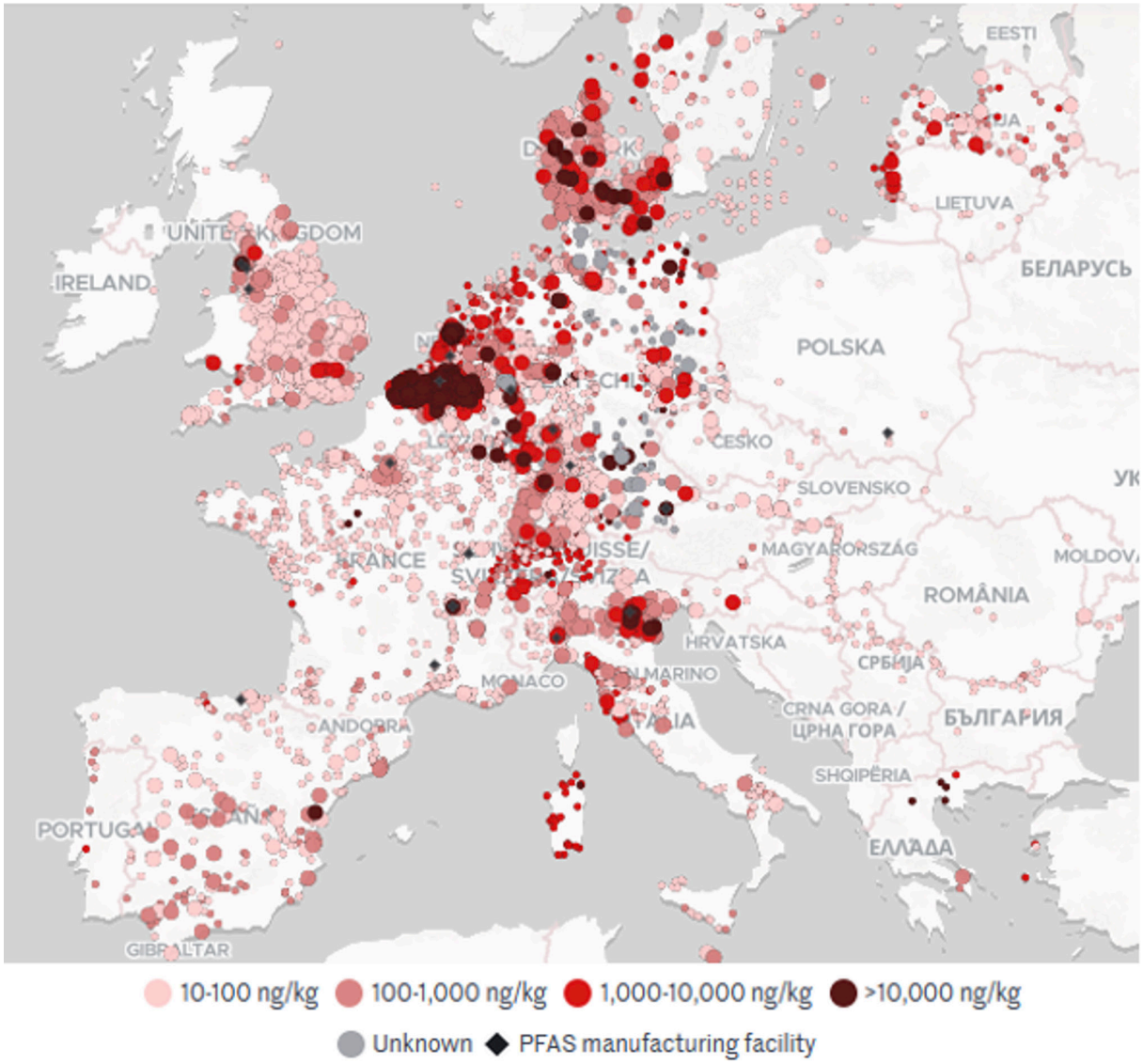


Figure 12: The Map of Forever Pollution in Europe. Source: Le Monde.[95]

A 2022 study also found that up to four PFAS (PFOA, PFOS, PFNA, and PFHxS)[s] in rainwater are often above drinking water limits in the United States and Denmark. The study also found that PFOS levels are often above Environmental Quality Standards for Inland European Surface Waters, and that atmospheric deposition of PFAS is ubiquitously contaminating soils around the world. [100]

Short-Chain vs. Long-Chain

PFAS can be further broken down into groups depending on the length of their carbon-fluorine chain. Depending on the sub-group of PFAS being discussed, short chain PFAS have up to six or seven fully fluorinated carbon atoms in their structure, long-chain PFAS hence contain more carbon atoms than this. **Long-chain PFAS, such as PFOA and PFOS, have received more attention from Governments and scientists around the world due to their toxic impact to human and environmental health**. Long-chain PFAS are becoming increasingly more regulated by systems such as the EU's REACH law and globally under the Stockholm Convention.[64] [101] [102]

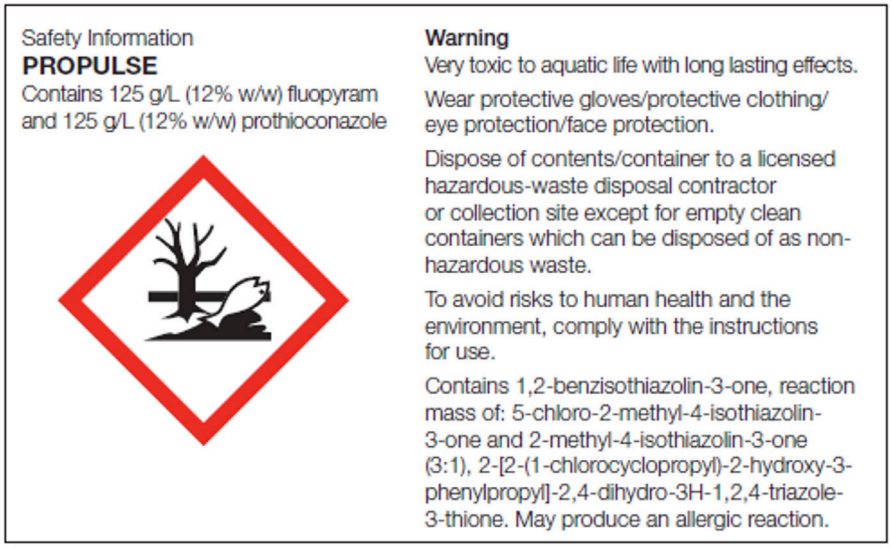
s PFNA: perfluorononanoic acid
PFHxS: perfluorohexane sulfonic acid

Short-chain PFAS, which came into existence in the 1970s, are commonly used to replace long-chain PFAS as they possess similar properties and receive decreased regulatory attention. For instance, fire-fighting foams have switched from using long-chain to short-chain PFAS in recent years.[97]

PFAS have even been used in pesticides, making up of 5% of total pesticide consumption in Denmark. In 2022, Danish farmers bought 209 tonnes of PFAS pesticides such as Propulse SE 250 (a fungicide), Legacy 500SC (a herbicide), and Lamdex (an insecticide). At least 13 different active substances used in pesticides, such as diflufenican and fluopyram, are termed PFAS and sold in Denmark.[103]

Bayer, a manufacturer of Propulse, uses fluopyram which is used to control diseases in oilseed rape. The product data label and the product safety data sheet contain no mention of the term PFAS, though they do mention that the product is "very toxic to aquatic life with long lasting effects" and that it is "Moderately mobile in soils."[104] Bayer already uses diflufenican in its Othello and Liberator wheat and barley herbicides. The company also plans to release CovintroTM, a diflufenican containing herbicide in the mid-2020s to help soybean and corn growers in the US.[105] [106] [107]

Financiers should heed the warning signs.


Safety Information
PROPULSE
Contains 125 g/L (12% w/w) fluopyram and 125 g/L (12% w/w) prothioconazole

Warning
Very toxic to aquatic life with long lasting effects.

Wear protective gloves/protective clothing/ eye protection/face protection.

Dispose of contents/container to a licensed hazardous-waste disposal contractor or collection site except for empty clean containers which can be disposed of as non-hazardous waste.

To avoid risks to human health and the environment, comply with the instructions for use.

Contains 1,2-benzisothiazolin-3-one, reaction mass of: 5-chloro-2-methyl-4-isothiazolin-3-one and 2-methyl-4-isothiazolin-3-one (3:1), 2-[2-(1-chlorocyclopropyl)-2-hydroxy-3-phenylpropyl]-2,4-dihydro-3H-1,2,4-triazole-3-thione. May produce an allergic reaction.

Figure 13: Part of Bayer's product label for its PFAS containing Propulse fungicide. Source: Bayer.[100]

There is a need for greater research into the health impacts of numerous PFAS. In Bayer's case this may be even more pressing as financiers could see this as another source of liability that it could potentially need to fund in the future. There may be extra costs on top of this if manufacturers of such products need to transition to less harmful products due to regulation or increased consumer pressure.

What are investors and corporates saying?

Planet Tracker analysed the discussion of PFAS across 28 companies over five years in annual reports and company transcripts and found that the chemicals did not feature very much. In total, **104 mentions of PFAS were found across nearly 3,500 documents**. Most of the focus in transcripts, where companies present to investors, focussed on the provisions made for expected and potential fines and litigation activities.

Solvay (SOLB)

Solvay previously purchased processing aids containing PFOA and PFNA which were used at its New Jersey facility in the United States. At the same site, PFAS were manufactured there under the name of Solvay Speciality Polymers USA for over 30 years.[108] Even though Solvay joined the EPA's voluntary programme to phase out the chemicals, doing so for both by 2010 and 2013 respectively (two years ahead of the deadline), it was still left financially exposed years later.[109]

Solvay repeatedly told investors on earnings calls that it didn't produce or sell the PFAS-containing processing aids that it was using on-site. Despite this, Solvay was planning provisions related to PFAS use from as early as 2019 and said in their mid-year earnings call that *"... environmental provisions were largely stable at a EUR 0.7 billion, and for the avoidance of doubt in relation to the PFAS matters that Ilham [CEO] mentioned based on all the information we have, we believe that we are adequately provisioned for such matters."*[105]

However, Solvay did not phase-out the use of fluorosurfactants (PFAS) at their New Jersey plant until June 2021, and provisions to deal with remediation costs were EUR 123 mn.[110] By Q3 2022 they had reduced this to EUR 93 million, and in Solvay's August earnings call with investors, were saying they were *"really pleased we reached a settlement with the New Jersey Department of Environmental Protection on PFAS"* on an anticipated cost of USD 175 mn.[111] [112] A court judgement released earlier this year confirmed a USD 179 mn fine broken into:[113]

- USD 3.8 mn for all costs incurred by the New Jersey Department of Environmental Protection,
- USD 75 mn for natural resource damages, and
- USD 101 mn to fund remedial projects.

Solvay is facing 35 separate litigation cases, mainly from private individuals, and still uses these fluorosurfactants in Spain and Italy, with a plan to phase them out by 2026.[114] [115]

Reporting on PFAS Releases

There is no reporting of PFAS releases to the E-PRTR. There is minimal reporting of a small number of PFAS to the United States' TRI, but note that were a mere 40 disclosures of PFAS releases by all US facilities over two years, beginning in 2020 – only six of these disclosures were made by petrochemical facilities. In reporting year 2023 there are a total of 189 PFAS that are reportable to the US EPA.[116] Can financiers be confident that companies are disclosing the information they should?

Actions for Financiers

For financiers to attain more information on companies' use and production of PFAS, financiers should demand from companies that they:

ASK 1

Transparently disclose, define strategies and set clear targets to reduce the impacts of plastics

- Disclose to organisations such as the CDP's plastic disclosure
- Establish a timebound strategy to reduce fossil fuel feedstock
- Transition to the production of safe, environmentally sound and sustainable plastics

ASK 2

Address polymers and chemicals of concern in their products

- Commit to identifying and eliminating the use of hazardous chemicals and additives in polymers
- Publicly report their progress

Further Reading

Is Bayer a litigation leading indicator? – the financial effect of litigation on Bayer and its investors

US EPA: Reducing your PFAS exposure

US EPA: Impacts of PFAS

Novel Entities: Case Study 5

Ocean Plastics

Issue

Most uncontrolled plastic waste ends up in the ocean. What it does when it's there is not well understood.

Relevance for Financiers

- Companies and brands have a reputational risk of being linked to ongoing and historical plastic pollution
- Banks need robust measures in place to minimise plastic-related financing risks

Case Study

There are three main forms of plastic pollution:

1. Macro (>5 mm)
2. Micro (<5 mm)
3. Nano (<1 µm)

In addition, **toxic chemicals can leach from plastics, such as phthalates**. Conventional plastics do not biodegrade, but due to hydrodynamics and exposure to light they may fragment into small particles which are readily taken up by marine organisms, and can travel through food webs, from zooplankton to larger fish and then into humans.

Plastic Pollution as a Planetary Boundary

The ubiquity of plastic in almost all natural environments on Earth has made this substance a key indicator of the Anthropocene[34] Plastics can cause disturbances to biosphere integrity, including changes in species distribution, through toxic and physical effects, especially in marine environments. Although plastics comprise a carbon-based polymer backbone, thousands of additional chemicals are incorporated into the polymers to allow for such properties as colour, flexibility, stability, water repellence, flame retardation and ultraviolet resistance.[48]

Some scholars argue that plastic litter in the marine environment in itself could fulfil the three criteria to impose a planetary boundary threat:[117]

1. Planetary scale exposure, which
2. Is not readily reversible, and
3. Eliciting a disruptive impact on vital earth system processes

Around 400 mn tonnes of plastic are wasted every year. To date humans have generated 7 bn tonnes of plastic waste, of which only 9% has been recycled.[118] [119] Mismanaged plastic waste can wash up in rivers and then end up in the sea: between 75 and 199 mn tonnes of plastic is currently found in our oceans.[9] [45] [46] [47] Ultimately, this marine plastic waste will end up at the bottom of the sea and remain there for geological timescales. Very little is known about the fate of plastic that ends up there. If some plastics can survive for 1,000 years in terrestrial

environments, how long could they last in ocean trenches that are kilometres deep, in pitch black darkness, cold, and at high pressure?[120]

Measuring Where Plastic Goes

Measuring how plastic waste enters the ocean is challenging. Plastic waste enters the ocean through stormwater runoff, through the washing of clothes and the consequent release of microfibers, is dumped on shorelines or is directly discharged at sea from ships.[121] One estimate is that 80% of annual plastic emission into the ocean comes from 1,000 rivers, and that the Philippines, India and Malaysia are the top 3 emitters, see Table 5.[122]

Table 5: Top ten countries by annual plastic emission into the ocean. Source: Meijer et al., 2021. [118]

Rank	Country	Plastic Emissions into the Ocean (tonnes yr-1)
1	Philippines	1,000,000
2	India	360,000
3	Malaysia	73,000
4	China	71,000
5	Indonesia	56,000
6	Myanmar	40,000
7	Brazil	38,000
8	Viet Nam	28,000
9	Bangladesh	25,000
10	Thailand	23,000

However, the top-ranked companies responsible for plastic pollution, according to Break Free From Plastics, are all headquartered in the US or Europe.[123]

Table 6: Top five companies responsible for plastic pollution. Source: Break Free From Plastic, 2022.[119]

Rank	Company	Plastic Production (tonnes yr-1)	Branded Plastic Waste Recovered (#) (# countries)
1	Coca-Cola	3,224,000	85,035 (78)
2	PepsiCo	2,500,000	50,558 (66)
3	Nestle	920,000	27,008 (64)
4	Unilever	713,000	22,938 (60)
5	Mondelez International	198,000	9,609 (59)

Why is Plastic a Problem?

There is a significant body of evidence that microplastics have negative effects in many species, including humans.[8] [124] These include oxidative stress, DNA damage, organ dysfunction, metabolic disorder, immune response, neurotoxicity, as well as reproductive and developmental toxicity. A variety of chronic diseases may also be related to microplastics exposure.[125]

Although a decade ago it was mostly a marine pollution issue, over the last decade researchers have found microplastics in:[126]

- Air, clouds and ocean spray
- Soil, snow, and ice
- Freshwater, sea water, and rainwater[127]
- Terrestrial biota, including within bodily tissues and gastrointestinal tracts of thousands of species, including humans.

There are 16,000 chemical compounds used in plastics. Of these, 4,200 are persistent, bioaccumulative, mobile, and/or toxic. Hazard data is not available for more than 10,000 of these chemicals. Some, such as phthalates, have severe toxic effects.[128]

Where does Plastic Pollution come from?

Globally, seven plastic polymers dominate global production:[124]

1. Polypropylene (PP,19%)
2. Low-density polyethylene (LDPE, 14%)
3. Polyvinylchloride (PVC, 13%)
4. High-density polyethylene (HDPE, 13%)
5. Polyethylene terephthalate (PET, 6%)
6. Polyurethane (PUR, 6%)
7. Polystyrene (PS, 5%)

Short-lived plastic items, such as packaging and textiles, make up almost two-thirds of all plastic waste. Of these, 19% are incinerated, 50% landfilled, and 31%, or 83 million tonnes, is either:[124]

- Dumped in uncontrolled dumpsites,
- Burned in open pits, or
- Leaked to the environment.

Funding The Plastic Industry: Sustainability at the Fringes

Planet Tracker analysed what Europe's top 30 banks are doing in relation to funding sustainable plastic production. We looked at over 4,000 publicly available documents spanning five years and found little encouragement. Many banks mention their own plastic waste, or how plastic credit cards were now being made of more sustainable materials. We found that addressing plastic pollution sits at the fringes of banks' lending activities and is addressed in specialty sustainable finance mechanisms, as outlined below.

BBVA, a Spanish bank, published its Sustainable Debt Financing Framework in November 2022 which outlined how it would finance or refinance bonds, certificate of deposits, commercial paper, or other eligible instruments to green projects in certain categories, which includes Pollution Prevention and Control. This outlines that funding to manufacturers of plastic in their primary form must manufacture products, exclusively financed by this capital, by:[129]

"...chemical recycling of plastic waste or derived wholly or partially from renewable raw materials (biomass, industrial or municipal bio-waste) that meet at least 27% lower emissions than the life-cycle emission of equivalent plastics in primary [form] manufactured from fossil fuels raw materials."

Other banks have similar approaches. ING also provide sustainable finance and sees the circular economy as an important means to reaching climate goals. As part of this, it structured a financing for Henkel, a German chemicals producer, which included a KPI on increasing their use of recycled plastic in all their plastic packaging.[130] Intesa SanPaolo's Sustainability Bond Framework excludes financing for solutions that extend the production and use of virgin plastic.[131] Other examples of plastic-related sustainable finance provision are:

1. HSBC was the lead manager on a USD 100 mn plastics reduction bond to Henkel for its circular economy activities, which includes the development of reusable and recyclable packaging.[132]
2. Danske Bank acted as sole lender and sustainability adviser on Svensk Plaståtervinning's SEK 655 million green term loan and revolving credit facilities to build an advanced plastic recycling plant in Sweden.[133]
3. Standard Chartered Bank's Sustainability Bond Framework prohibits the financing of projects that chemically recycle plastic waste.[134]

Funding Needs

An analysis of facilities reporting to the TRI in the United States showed that **over 800 facilities could not implement pollution reduction measures due to the lack of investment capital**. Approximately 7% of these facilities are active in the petrochemical sector and includes facilities operated by Arkema, BASF, Indorama, Solvay, and The Chemours Co. The top five chemicals where reduction measures could not be implemented are:

1. Methanol
2. Ammonia
3. Styrene
4. Mercury
5. Acrylic acid

This is a small subset of companies that have been identified using publicly available information. Banks and investors have much closer relationships with companies and access to more business information to find similar funding opportunities. Financiers have sustainability-aligned funding frameworks in place, as outlined above, which can be used to enable and quicken the pace of the transition of petrochemical companies.

Actions for Financiers

For financiers to attain more information on companies' use and production of plastic, financiers should demand from companies that they:

ASK 1

Transparently disclose, define strategies and set clear targets to reduce the impacts of plastics

- Disclose to organisations such as the CDP's plastic disclosure
- Establish a timebound strategy to reduce fossil fuel feedstock
- Transition to the production of safe, environmentally sound and sustainable plastics

ASK 4

Establish dedicated governance

- Establish Board-level responsibility and oversight for achieving plastic sustainability commitments
- Link a share of management compensation to circularity commitments

ASK 5

Publicly support an ambitious international legally binding instrument for ending plastic pollution

- Advocate for common legally binding measures across the full plastics lifecycle designed to reduce plastic production and consumption, such as the Global Plastics Treaty and the Global Framework on Chemicals
- Refrain from lobbying and obstructing the ambitious outcomes aimed for in international plastic reduction efforts

Further Reading

Plastic Recycling Deception: debunking the narrative that recycling as the panacea for plastic pollution

What financial institutions should take away from the 4th round of Global Plastics Treaty negotiations

Toxic Footprints Europe: identifying the most polluting petrochemical producers in the EU Trilateral Region

Exposing Plastic Risk: an analysis of chemical company plastic-related risk disclosures

Plastic Risk – Measuring Investors' Risk in the Plastic Sector: analysing the equity risk premia of 150 top corporates in the plastic value chain

Packaging as an Asset: the benefit of treating packing as an asset rather than a liability

Novel Entities: Case Study 6

Novel Entities Risks are Present in Most Sectors

Issue

Chemicals are extraordinarily useful, but being associated with the wrong ones can cause damage to a brand's reputation and have a negative impact on company profits.

Relevance for Financiers

- Novel entities are used throughout most sectors, including consumer goods, food and beverage, agriculture and more.

Case Study

Most economic activities are dependent in some way on the chemical industry, and thus most economic sectors carry some novel entities risks, although it is very difficult to map this.[59] The American Chemistry Council estimates that, of the USD 449 bn sold by the US chemical sector to other sectors:[135]

- USD 100 bn (22%) go to health care and pharmaceuticals
- USD 81 bn (18%) to rubber and plastics
- USD 23 bn (5%) to paper and printing
- USD 23 bn (5%) to agriculture
- USD 19 bn (4%) to computer and electronics
- USD 14 bn (3%) to textiles & apparel

Products from those sectors are then used in other industries, making the presence of novel entities pervasive in the global economy.

The pathways followed by chemical products entering the environment are complex. Pharmaceuticals, cleaning products and cosmetics are consumed and indirectly released to the environment, normally becoming partly treated by wastewater treatment plants. Other chemicals, like pesticides and fertilisers, are directly released into the environment upon use. Tyres, paints, and textiles are "unintentionally" released through the wear and tear of their usage, possibly over decades. Once they reach their end-of-life, a very limited volume of chemicals is recycled, some are dispersed in the environment, and most are disposed in waste management facilities, some of which are illegal or poorly managed, which can cause chemicals to leach into the environment.[59]

However, this case study shows that companies are only partly aware of the risks novel entities pose to their businesses.

Plastic Risk Disclosures

Planet Tracker's analysis of corporate plastic risk disclosures – see Exposing Plastic Risk - shows **that circularity is the main topic of conversation in public reports and transcripts**. The analysis of nearly 60 upstream, midstream, and downstream companies over five years shows that companies further up the value chain push circularity messaging more than its downstream peers. Less focus is placed on the risks associated with pollution, feedstocks, and of the types of products it manufactures.

Companies face many risks associated with their production, use, and disposal of novel entities, and while transitioning to a circular economy is one risk (or opportunity) confronting businesses, is it the most significant or pressing issue for investors? The sections below outline how various risks could impact companies in various sectors in relation to their exposure to novel entities.

Consumer Goods

Consumer goods companies are large users of plastics in the products they manufacture. Unilever, a corporate sustainability champion, revised its 27 ESG targets in April 2024, four of which related to plastic use.[136] The original targets are show in Table 7.

Table 7: Unilever's corporate plastic targets

Target	Description	Progress vs. Target
1	Use 25% recycled plastics in our packaging by 2025	88%
2	Collect and process more plastic packaging than we sell by 2025	61%
3	Reduce our virgin plastic footprint by 50% by 2025	45%
4	100% of our plastic packaging should be reusable, recyclable or compostable by 2025	53%

The first two targets have remained the same after the revision but targets 3 and 4 have been reduced in scope. Regarding target 3, Unilever has given itself an extra three years to achieve a goal that is 20% less ambitious and has given itself an extra 5-10 years to achieve target 4. This is worrying as a sustainability leader is struggling to meet its own targets. Equally concerning is that Unilever considers plastic packaging a *principal risk*, defined as something which has the potential to impact at least 1% of its turnover. Identified in its CDP responses and Annual Reports, Unilever states that emerging regulations taxing or banning plastics, competition for alternatives and higher material prices could all impact its profitability and reputation. This is not an issue that is unique to Unilever and should serve as a wake-up call to those corporates not currently addressing plastic waste.[137] [138] Also see Table 6 for the most polluting brands linked to plastic waste.

Agriculture

Agriculture, or more precisely farmers, sit at the start of the value chain for many companies. It's typically where the margins are lowest and innovation the slowest. It's also the part of the value chain most directly connected to nature – completely dependent on it and exposed to the varying extremes resulting from climate change.

Pesticides[t] are novel entities which are released directly into the environment. Planet Tracker showed in Case Study 4: PFAS and the Danger of Forever Chemicals that some pesticides contain PFAS, though this is not the norm. The global crop protection market was valued at USD 78.7 billion in 2022, with herbicides representing 47% and glyphosate the leading product by margin.[139] Exposure to pesticides can cause acute and chronic health conditions and this is especially true for highly hazardous pesticides (HHP). The UN has developed eight criteria to define whether a pesticide is a HHP and has adopted a resolution that recognises HHPs as an issue of international concern.[140]

As regional climates change, so do species' ranges. This means that new pests will likely appear and pose new dangers to agricultural production.[141] This will be considered an opportunity by pesticide manufacturers to tap into new markets and develop new products. However financiers beware, there is an increasing amount of green financial regulation which will limit or prevent financiers' ability to profit from the industry. See Table 8, which shows some of these regulations coming into effect around the world.

Table 8: Selected financial regulations relevant to pesticides. Source: ShareAction.[142]

Jurisdiction	Name	Details
European Union	Green Taxonomy	Defines economic activities considered sustainable. It highlights that chemical pollution is contrary to sustainable economic activity.
	Sustainable Finance Disclosure Regulation	Financial institutions must report their share of investments in chemical-producing companies, including pesticide companies.
South Africa	Green Finance Taxonomy	Taxonomy-aligned investment must minimise excessive use of pesticides and associated pesticide pollution.
Colombia	Taxonomía Verde de Colombia	The Taxonomy identifies natural resource pollution from pesticides as contrary to sustainable economic activity.

There is also a reputational risk of being associated with pesticide production. Public Eye and Unearthed found that many pesticides that have been banned in the EU for decades can still be manufactured in, and exported by, EU member states. The report found that the UK ranked as the highest exporter, exporting over 32,000 tonnes of these pesticides, higher than the next three countries combined – Italy (9,500 tonnes), Germany (8,100 tonnes), and the Netherlands (8,000). The biggest corporates in this field were Syngenta (29,300 tonnes), Corteva (10,800 tonnes), and Finchimica (7,900 tonnes). The top pesticides which were exported include paraquat, 1,3-dichloropropene, and cyanamide.[143]

t 'Pesticides' is used as a collective term in this report for insecticides, herbicides, fungicides and other synthetic chemicals

Genetically modified organisms (GMOs) can also be considered novel entities since species receive traits that they may not have received in nature. GMOs are often given traits which give them tolerance to specific herbicides. What is perhaps less well known is that the company manufacturing the GMO and the herbicide are often the same company. This "integrated product offering" is great for businesses as it locks in users to two products that are dependent on each other, and which are both patented by the same company. Examples of this in practice include:

Table 9: Examples of GMO and herbicide manufacturing

Company	Herbicide	Example Crops
Bayer CropScience (formerly Monsanto)[144] [145]	Glyphosate	Roundup Ready Crops such as soy, maize, and cotton
	XtendiMax (Dicamba)	XtendFlex Crops such and soy and cotton.
Corteva (formerly Dow AgroSciences)[146]	Enlist Duo (2,4-D and Glyphosate combination)	Enlist Crops such as soy, maize, and cotton
Syngenta[147]	Touchdown (Glyphosate)	Agrisure Trait crops, such as soy and maize.
BASF[148]	Liberty (Glufosinate)	LibertyLink Crops such as soy, maize, and cotton.

Novel entities do not even need to have caused human or environmental health impacts for them to represent a financial risk. In September 2017 Syngenta was ordered to pay USD 1.51 bn to 650,000 corn producers, grain handlers, and ethanol plants over the "aggressive commercialisation" of its Agrisure GMO seeds. The farmers alleged that the company should have delayed putting these seeds on the market until Chinese authorities had approved their import.[149]

Food and Beverage

Plastic is used extensively in the food and beverage industry and so waste is a significant issue. The FAO estimated that 12.5 million tonnes of plastic was used in food production in 2019 – 3% of the global plastic production that year.[150] [151]

One study of food and beverage company disclosures relating to plastic pollution found that **recycling is still the dominant narrative, with little consideration of markets with poor waste management infrastructure**. The authors also found that the transition to sustainable packaging by these companies is both slow and inconsistent, and that company reports more readily focus on commitments rather than actions.[152]

A similar study created a Cheap Talk Index (CTI) by analysing climate disclosures in over 14,600 reports by companies in the MSCI World Index over ten years. The CTI, a measure of the likelihood that companies turn reporting into tangible actions, showed that:[153]

- Voluntary climate disclosures are associated with more cheap talk
- Cheap talk correlates with increased negative news coverage and higher emissions growth

These are just two examples of how external parties, using only publicly available information, can make very robust assessments of the reputational risk associated with failing to deal with environmental issues, such as chemical and plastic pollution.

Textiles

PFAS have many uses in textiles, one of which being their ability to waterproof clothing. Some famous brands, such as GORE-TEX,[u] use products such as PTFE (a fluoropolymer) which are part of the PFAS family – see Figure 10.[154] PFAS are also used to treat leather, carpets, and other household textiles. One study by the Danish EPA found that clothing represents about 50% of the consumption fluorotelomer and fluorotelomer-based polymers, a PFAS sub-type, globally. It also found that alternatives for PFAS, like paraffin and silicone-based chemicals, do exist.[155] [156]

There are three life-cycle phases where PFAS in textiles will escape to the environment, (i) manufacturing, (ii) use, and (iii) disposal. Studies have found that PFAS are likely to continue to wash off textile products gradually, and that older materials may be a greater source of PFAS loss than newer products – a toxic debt. The disposal of textiles, such as carpets, to landfill can also be great sources of PFAS pollution. Once discarded to landfill PFAS in textiles will be exposed to leaching and anaerobic biodegradation, providing a concentrated and continued source of many PFAS compounds.[157]

Table 10 shows some famous brands containing PFAS and the companies that produce them. Note that, as with our Bayer pesticide example in Case Study 4, no mention of the term "PFAS" can be found when looking at the product ingredient list/description. One heuristic to follow is that the presence of fluorine is a very strong indication of the presence of PFAS.[158] At the very least, companies should be publicly disclosing when PFAS are being used in consumer-facing products.

u Other brands include Scotchguard®, Teflon®, NanoTex®, GreenShield®, Lurotex®, Unidyne®, and Crypton Green®.[97]

Table 10: PFAS-based textile impregnation agents and their producers. Source: Danish EPA.[152]		
Producer	**Brand Name**	**Fluorinated Compounds (as indicated by producer)**
DuPoint / Huntsman	Advanced Dual Action Teflon fabric protector. Marketed via Huntsman as Oleophobol CP	Fluoroalkyl acrylate copolymer dispersion
	Repel Teflon fabric protector High performance Repel Teflon Advanced Dual Action Teflon fabric protector Tri-Effects Teflon fabric protector. Marketed via Huntsman as Oleophobol CP	
	Release Teflon High Performance Release Teflon Ultra Release Teflon	
BigSky Technologies	GreenShield	Fluoroalkyl acrylate and alkyl acrylate copolymers. Supposedly environmentally friendly by 8-10 times less use of fluorocarbon.
BASF	Lurotex Protector RL ECO	Supposedly environmentally friendly by 8-10 times less use of fluorocarbon.
Pulcra Chemicals	Repellan KFC	Perfluoroalkyl acryl polymer
Rudolf Group	Rucostar EEE6	Dendrimers of fluorocarbon, which reduce the amount of fluorocarbon by 50 % compared to conventional finishing with a better effect. Solvent free
	Bionic Finish	By the use of starlike, branched polymers, water and oil-repellent effects with a simultaneously reduced fluorocarbon resin content can be obtained. The fluorocarbon resins included are not specified
	RUCO-GUARD	Water or solvent-based fluorocarbon polymers, fluorocarbon resins or boosters. Based on C6-based fluorocarbon polymeric disper-sions
	RUCOSTAR RUCO-COAT RUCO-PROTECT RUCOTEC RUCO	Water or solvent-based fluorocarbon products (some of the brands also available as fluorocarbon free). Based on C6-based fluorocarbon polymeric dispersions
Daikin	Unidyne	Fluoroalkyl acrylate copolymer
Nano-Tex	Resist Spills	C6-based "PFOA free" repellency solution. Each fibre has been fundamentally trans-formed through nanotechnology

Toxicity ≠ Quality

Despite their toxicity, PFAS and other chemical substances are useful, hence their presence throughout the global economy. This usefulness is also a barrier to their substitution and removal from manufacturing processes. A Planet Tracker analysis of **manufacturing facilities reporting to the US TRI found that 2,800 could or would not reduce or replace the use of certain chemicals due to fears that product quality would decline**. A little over 3% of these, 90 facilities in total, are petrochemical facilities. Figure 14 shows 819 facilities disclosing this over the last five years. The most common chemicals that this reason was given for are for lead compounds (144), nitrate compounds (106), and chromium (75).

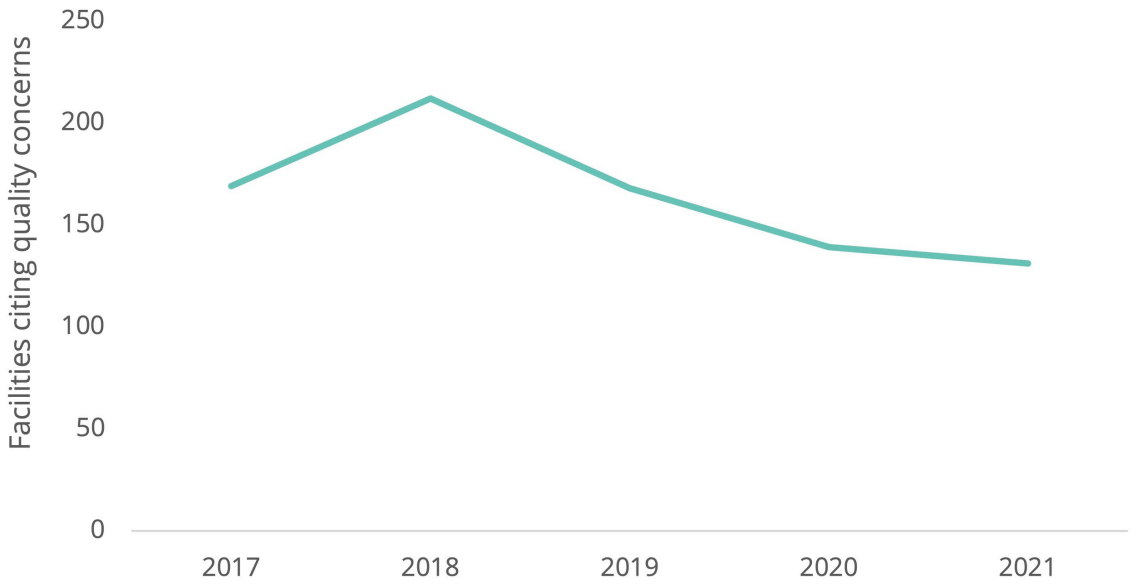


Figure 14: Facilities citing fears of declining product quality in relation to reducing toxic emissions.

Can regulators encourage or incentivise the use of environmentally substitutes so that toxic chemicals can be phased out?

Actions for Financiers

For financiers to attain more information on companies' use and production of novel entities, financiers should demand from companies that they:

ASK 1

Transparently disclose, define strategies and set clear targets to reduce the impacts of plastics

- Disclose to organisations such as the CDP's plastic disclosure
- Establish a timebound strategy to reduce fossil fuel feedstock
- Transition to the production of safe, environmentally sound and sustainable plastics

ASK 2

Address polymers and chemicals of concern in their products

- Commit to identifying and eliminating the use of hazardous chemicals and additives in polymers
- Publicly report their progress

Further Reading

Unilever's Revised Sustainability Targets – a Blog and Data Dashboard outlining how and why Unilever has removed and downgraded some sustainability targets

Conclusion

Novel entities are relevant to the financial community because of their impact on environmental and human health, which could result in significant corporate litigation.

These substances, often new or previously unknown to Earth's systems, can harm human health and biodiversity, pushing humanity beyond planetary boundaries – the thresholds which define the Earth's safe operating space. We appear to be exceeding our novel entities planetary boundary, but with limited information on many novel entities, or even worse no analysis at all, the focus needs to be on their impact on environmental and human health. However, the number of scientific studies is rising dramatically, particularly evident in substances associated with plastic products.

For financiers and corporations, environmental and health impacts are particularly concerning as they can result in litigation and regulatory scrutiny. Attempts have been made to regulate novel entities, such as the UN's Global Framework on Chemicals and the Montreal Protocol. In addition, global goals include reducing the risks from hazardous chemicals and plastic pollution, aligning with biodiversity targets (Target 7) and sustainability goals (SDG 12.4). As governments negotiate a legally binding Global Plastics Treaty, the financial sector needs to ensure this rising risk profile is accurately priced.

Financiers can mitigate such risks by ensuring a transition to more sustainable substances and reduce the growing "toxicity debt" which can leave companies financially exposed for decades to come. A delayed shift to sustainable practices increases both financial risks and long-term environmental liabilities.

Planet Tracker illustrates the various risks of novel entities to companies and their financiers through six case studies.

Case Study 1: The Known Unknowns of Novel Entities

Novel entities present significant risks to the financial community due to their largely unknown long-term impacts on human health, the environment, and planetary systems. Many chemicals are not fully monitored or studied, leading to "unknown unknowns" regarding their toxicity and impact. Global chemical production is projected to triple by 2050, amplifying concerns. Furthermore, toxic footprints – which measure environmental and health impacts – show significant national and corporate risks. Up to 80% of chemical stocks are currently contained within products still in use, meaning that there is a large stockpile of chemicals due to be disposed of which could be a significant source of financial risk for companies.

Case Study 2: Regulating and Litigating Against Novel Entities

Governments and international bodies are implementing stringent regulations to control toxic chemical releases, as seen with the EU's REACH and the Stockholm Convention. These regulations focus on banning or reducing hazardous substances, which can lead to significant financial impacts for companies involved in their production or use.

Financiers must recognize that the use of toxic chemicals can result in material damages, liability from lawsuits, and substantial litigation costs, as exemplified by the PFAS-related fines received

by BASF, Bayer, and 3M. Over 100 consumer-facing companies are attempting to get ahead of the curve, including H&M and Inditex, who have supported a ban on the use of PFAS.

Case Study 3: Chemical Production Outpaces Assessment Capacity

Presently, we are witnessing a rapid growth in chemical production, particularly in regions with less stringent environmental protections, like Asia. Global trade in chemicals has tripled since 1995, and financiers must consider the potential long-term liabilities associated with insufficiently tested chemicals. Chemical production is dominated by China, the EU, and the U.S., however, regulatory frameworks vary, and many chemicals are not adequately assessed for environmental and health impacts. For instance, the U.S Toxic Substances Control Act contains a list of about 86,000 chemicals, but the U.S. Toxics Release Inventory only requires corporate disclosures for less than 800 toxic chemicals.

Case Study 4: PFAS and the Danger of Forever Chemicals

PFAS, often referred to as "forever chemicals," are used in various industries and can persist for decades in the environment, leading to litigation risks for companies long after their use. The growing regulatory focus on PFAS, alongside public awareness of their environmental and health risks, means companies may face future financial burdens in transitioning to safer alternatives. This could lead to increased operating costs and impact profitability. For example, Bayer's use of PFAS in pesticides and Solvay's costly litigation due to PFAS exposure highlight these risks.

This rising concern emphasizes the need for financial institutions to accurately assess and evaluate their risk to companies involved in PFAS production.

Cast Study 5: Ocean Plastics

An estimated 75 to 199 million tonnes of plastic can currently be found in our oceans. The Philippines, India, and Malaysia are the top countries responsible for ocean plastic pollution, but Coca-Cola, PepsiCo, and Nestle, all U.S. or European companies, are ranked as the top producers of plastic pollution.

All companies face reputational risks linked to plastic pollution. Plastics, especially micro and nano plastics, pose significant threats to marine ecosystems, human health, and planetary boundaries, making their management critical.

Banks must also manage their financing risks associated with the plastic industry. Despite creating and promoting sustainable financial instruments, many banks treat plastic pollution as a peripheral issue. Some, like BBVA, ING, and HSBC, offer specific green financing frameworks for recycling and circular economy projects. However, the overall financial commitment to sustainable plastic solutions remains minimal.

Case Study 6: Novel Entities Risks are Present in Most Sectors

Novel entities are prevalent across numerous sectors such as consumer goods, agriculture, food and beverages, textiles, and healthcare. Most economic sectors depend on novel entities and whether used in products or processing, they pose environmental and financial risks. Companies need to assess such dangers.

Products used in these sectors can be directly or indirectly released into the environment,

whether in the form of pesticides sprayed onto crops, plastic-based textiles which are washed using chemical detergents, or when textiles are treated with stain repellent chemicals. These novel entities can enter the environment in complex ways that can harm ecosystems and human health, but these are not well understood or disclosed. An analysis of corporate plastic-related risk disclosures over five-years shows that there is a focus on discussing circular economy-based solutions, rather than the risks associated with pollution and feedstocks used.

Action Stations

Financiers have a chance to correct the course on novel entities. Shareholders can place pressure on management teams to transition to sustainable alternatives, banks can impose stricter lending criteria, and insurance companies can adjust premiums on companies manufacturing and using the most toxic chemicals. Planet Tracker has launched its petrochemical investor statement, with 73 investors representing USD 6.8 trillion AUM supporting it. As a simple first step, financiers can sign up to this statement, asking petrochemical companies to:

ASK 1	Transparently disclose, define strategies and set clear targets to transition to production of safe, environmentally sound and sustainable plastic
ASK 2	Address polymers and chemicals of concern in their products
ASK 3	Build sustainable infrastructure for production of sustainable materials
ASK 4	Establish dedicated governance
ASK 5	Publicly support an ambitious international legally binding instrument for ending plastic pollution

Novel entities represent a financial time bomb for companies and their financiers, but with proper management and action taken today, this can be reduced. Investors who choose to ignore the impending litigation have to rely on their market timing skills – i.e. sell their positions before others. As Jack Bogle, founder of Vanguard stated, "The idea that a bell rings to signal when to get into or out of the stock market is simply not credible. After nearly fifty years in this business, I don't know anybody who has done it successfully and consistently. I don't even know anybody who knows anybody who has."

Appendix 1

Financial Institution Engagement Sheet

ASK 1: Transparently disclose, define strategies and set clear targets to transition to production of safe, environmentally sound and sustainable plastic.

Background

There is extensive research showing that plastic production and waste, both the plastic and additives it contains has many effects on the environment and human health.

This poses significant plastic-related risks to petrochemical companies producing the plastic polymers. Their risk register should include exposure to CO_2 emissions, harmful toxic discharges, visible and invisible plastic pollution (for land, water and air), chemical additives exposure and rising harm to people and nature.

These risks include regulatory risks (such as tighter emission controls, bans, taxation, and extended producer responsibility costs), reputational risks, plastic-related litigation, and increased consumer demand for safe and more sustainable products.

Investors and lenders in the plastic value chain are financially exposed to these plastic- related risks. Financial institutions should be contemplating the probability of substantial liabilities.

Investors should be pressing corporates to address these risks. A key part of this for petrochemical companies is to report on their plastic impacts and work to set out plans to transition away from current business practices towards safe, environmentally sound production.

Corporate transparency on current plastic impacts can be provided by disclosing data in the CDP plastic module and to the TNFD. Public explanation of transition strategies and target setting can help elucidate how a corporate intends to reduce its risk over time.

We note that CDP has gathered more than 300 investors representing more than USD 29 trillion in assets to call for better disclosure of environmental data. Target companies include some of those which are a focus for petrochemical investor statement, so investors may want to add their support to the CDP campaign.

Q1: Do you report on your plastic impacts via a standardised framework such as CDP?

Target: Start disclosing plastic metrics to the likes of CDP or TNFD.

Q2: What are your company's targets for refillable and reusable content?

Target: The replacement of virgin plastic in packaging with refillable and reusable content when applicable.

Q3: Do you intend to set targets to transition away from virgin fossil fuel feedstocks?

Target: Establish targets for non-fossil fuel production

Q4: Are you investing in the production of sustainable (non-fossil fuel) plastic substitutes and moving away from single use plastic?

Target: Establish targets for non-fossil fuel production and for decrease in SUP output, ideally a capex number

Q5: What strategies are in place to mitigate the risks associated with reliance on future, unproven technologies for achieving your sustainability ambitions?

Target: Investors need to assess the company's backup plans and interim solutions that ensure progress towards climate targets, even as future technologies are being developed.

ASK 2: Address polymers and chemicals of concern in their products.

Background

Plastic polymers contain toxic and hazardous chemicals. Out of the 16,000 chemicals present in plastics over 4,000 have been identified as toxic.[124] Many of the chemicals used have yet to be fully tested for their impacts on human health and the environment.

Chemicals of concern have been found in plastics across a wide range of sectors and products value chains, including toys, packaging (including food contact materials), electrical equipment, vehicles, textiles, building materials, medical devices, personal care products, and agriculture.

Chemicals of concern can be released from plastic along its entire life cycle. This includes the production of polymers, the manufacture of plastic products, during their use and at the end of life. Poorly managed plastic waste is an important route for these chemicals to enter the air, water and soils.

Despite knowing that many chemicals used or produced by petrochemical facilities can be highly toxic, reporting requirements in many jurisdictions and loopholes in enforcement mean companies can often hide their toxic footprints. This leaves local communities in the dark on their exposure to potentially harmful chemicals.

When significant health impacts from chemicals are found and regulators move to prohibit use, banned chemicals are often replaced by similar substitutes. This regulatory arms race tilts in favour of the plastics industry as pre-marketing requirements for testing are low, whilst evidence of harm may take years to emerge.

However, the impacts of plastic production and use is a growing area of academic focus. Research into the harmful effects of plastics and associated chemicals on human health has risen dramatically in recent years.

The growing focus on the health and environmental impacts of plastics is a ticking timebomb for the industry. Although we are yet to see a significant amount of successful litigation around harm caused by plastic, the potential impact is huge. The Minderoo foundation has estimated that the social costs arising from all forms of plastic-related pollution to be hundreds of billions of dollars each year. Currently this potential risk is not reflected in plastic producer valuations.

Q1: How are you addressing the use of toxic chemicals in your products and value chain?

Target: Establish a clear strategy for risk mitigation from major litigation.

Q2: How are you addressing the use of toxic chemicals in your products and value chain?

Target: Establish targets and investments to minimise the use of toxic chemicals in own products and work with suppliers on the same issue.

Q3: Does the company have a strategy to phase out or substitute chemicals of concern in its products?

Target: Chemicals of concern in its products are identified and transparently disclosed, alongside the methodology used for this process. The company sets out a plan to phase out or substitute chemicals of concern.

Q4: Do you currently publicly disclose your product portfolio and products produced by manufacturing location?

Target: Production details for facilities are made publicly available and details of toxic spills are shared promptly and in full.

Q5: Will the company align with the first of the Principles for Chemical Ingredient Exposure and move to disclose all intentionally added chemical ingredients?

Target: A list of all intentionally added chemical ingredients is made publicly available

ASK 3: Build suitable infrastructure for production of sustainable materials.

Background

The design of petrochemical infrastructure is a highly technical area. Transitioning towards a sustainable industry will likely be a slow process with investment in new technologies alongside retrofitting of existing infrastructure.

Given often multi-decade lifespans for plants, new investment should be limited to technologies and infrastructure which offer a path towards a sustainable future.

It important to question the technologies put forward as part of a transition plan. For instance, does the company intend to invest in pyrolysis as a feedstock source? This would suggest also tying the company to virgin fossil fuel supplies over the medium-term, which is not aligned with a net zero future.

Investors should ensure that capex plans are aligned with this transition and question investment in infrastructure without a clear plan for how it will be part of a sustainable future.

Q1: How do you plan to transition to emissions-free or emissions-neutral feedstock by 2050?

Target: The company sets out a strategy for a feedstock transition and details the technologies and investment required.

Q2: If the company intends to invest in gasification - Does the company have a plan to manage the risks of toxic by-products from gasification and ensure it is zero emissions?

Target: Any investment in gasification includes a strategy to manage toxic emissions and ensure it is part of a net-zero future.

ASK 4: Establish dedicated governance.

Background

Greenwashing, whereby companies make themselves appear more environmentally friendly than they really are, has become a many-headed beast. There are several forms of greenwashing that investors should be wary of as petrochemical companies transition to a sustainable business model. We highlight two below:

Greenlighting occurs when company communications spotlight a particularly green feature of its operations or products, however small, to draw attention away from environmentally damaging activities being conducted elsewhere.

Greenrinsing refers to when a company regularly changes its ESG targets before they are achieved.

Greenwashing risks regulatory scrutiny and potential fines or legal action. It could also mislead as to the level of risk a company is exposed to if it is thought to be more sustainable than reality. Ensuring that there is strong governance with respect to sustainability strategies and targets is a key way to reduce the risk of greenwashing. We highlight two areas investors should monitor below.

Firstly, investors should not assume that corporate sustainability policies or positive environmental statements from management are reflected in executive compensation packages. Most companies lag in integrating sustainability goals into management compensation, or these become irrelevant when other financial goals are achieved. Often, sustainability goals can be over-ridden by financial metrics, making them irrelevant. Investors concerned about commitment to sustainability targets should push to have these form a meaningful part of management compensation setting.

Secondly, investors should question corporates on their membership of trade associations or other bodies which do not align with their own stated sustainability goals. At the very least, this misalignment should be explained. Investors need to clarify this strategic confusion; they need to know whether the corporate's announced strategy is merely greenwashing, whilst they use trade bodies to lobby against action behind the scenes.

Q1: Does the management team operate their facilities in the safest way using up to date emission control technologies?

Target: Reveal the capex on up-to-date emission control technologies.

Q2: How is your company measuring plastic related risks?

Target: Creation of contingency plans on the risks linked to plastic; evaluation whether risks are priced into capital markets.

Q3: Can you detail how sustainability goals, especially around transition, are integrated into executive compensation and incentive structures?

Target: Introduction of a material portion of performance-linked pay which is tied to sustainability targets.

Q4: Is your company actively auditing and assessing the alignment of your trade associations' policies with your corporate sustainability goals?

Target: The company publishes details of its memberships and affiliations and either abandons those which are incompatible with its sustainability goals or sets out how it will work to change the association's stance.

ASK 5: Publicly support an ambitious international legally binding instrument for ending plastic pollution.

Background

The Intergovernmental Negotiating Committee (INC) on plastic was created by the United Nations Environment Programme (UNEP) and began work in the latter half of 2022. It aims to complete the negotiations by the end of 2024.

The treaty aims to create an Internationally legally binding instrument to address plastic pollution both on land and in the marine environment. The instrument has the goal of addressing the environmental and health harms associated with plastic.

There have so far been four rounds of negotiations, with the latest concluding in Canada at the end of April. The 5th round is scheduled for Busan, Korean in November 2024 when it is hoped the treaty will be finalised.

However, despite the four rounds of negotiation so far, there remain several contentious points which remain to be decided. Most notably, these centre on the scope of the treaty and whether it should include focus on production reduction or only on waste management.

Petrochemical companies are very aware of the potential threat a comprehensive global plastics treaty could represent and have been increasing their efforts to shape the negotiations. This sits alongside their ongoing efforts to lobby against or water down national level efforts.

At INC-4 in Canada there was a 37% increase in the number of petrochemical linked lobbyists and industry representatives versus the prior negotiating round according to analysis by CIEL. This underlines that the industry is stepping up its obstructive tactics as the treaty nears completion.

Q1: Will you support an ambitious Global Plastic Treaty at INC-5 in Busan?

Target: Management agrees to the inclusion of production measures (for example, extended producer responsibility, EPR) as part of addressing the 'full lifecycle of plastics' in tackling plastic pollution.

Appendix 2

National and Regional Chemical Inventories

A list of national and regional chemical registries from Wang et al (2020)[7]

Geography	Country	Chemical Inventory Name	Chemicals (with CAS #)	Data
Asia	China	Inventory of Existing Chemical Substances Produced or Imported in China (IECSC)	45,643 (81%)	Registration numbers, chemical name, molecular formula for some chemicals.
	Japan	List of existing and new chemical substances under the Chemical Substance Control Law (CSCL)	58,314 (82%)	Registration numbers, chemical name.
		List of existing and new chemical substances under the Industrial Safety and Health Act (ISHA)	48,232 (30%)	Registration numbers, chemical name.
	India	Inventory of Hazardous Chemicals Import in India (ICHCI)	182 (100%)	Registration numbers, chemical name, imported, amounts.
	Malaysia	Chemical Information Management System (CIMS)	1,363 (100%)	Registration numbers, chemical name, imported, manufactured amounts.
	Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	22,009 (100%)	Registration numbers, chemical name.
	South Korea	Korea Existing Chemicals Inventory (KECI)	44,502 (87%)	Registration numbers, chemical name, regulatory status.
	Taiwan	Taiwan Chemical Substance Inventory (TCSI)	105,650 (72%)	Registration numbers, chemical name.
	Thailand	Thailand Existing Chemicals Inventory (TECI)	7,196 (100%)	Registration numbers, chemical name, regulatory status, volumes.
	Vietnam	National Chemical Inventory (NCI)	31,745 (100%)	Registration numbers, chemical name, regulatory status.
Europe	European Union	REACH Registered Substances	26,865 (71%)	Registration numbers, chemical name, tonnage band, production, use...
		REACH Pre-Registered Substances	145,299 (81%)	Registration numbers, chemical name, related substances...
	Nordic Countries	Substances in Preparations in Nordic Countries (SPIN)	31,738 (99%)	Registration numbers, chemical name, exposure, total use, use category...
	Russia	Russian Register of Potentially Hazardous Chemicals and Biological Substances (RPOHV)	11,058 (100%)	Registration numbers, chemical name, molecular formula, registration info.
	Switzer-land	List of new substances notified or registered in Switzerland (NSNRS)	1,397 (62%)	Registration numbers, chemical name.
	Türkiye	Former Turkish Chemical Substance Inventory (TCSI)	2,880 (100%)	Registration numbers, chemical name.
North America	Canada	Domestic Substances List	28,109 (89%)	Registration numbers, chemical name, regulatory status...
	Mexico	National Inventory of Chemical Substances of Mexico (INSQ)	5,852 (100%)	Registration numbers, chemical name, inclusion in TSCA, ecotoxicological data, persistence, bioaccumulation...
	United States	Toxic Substances Control Act (TSCA) Chemical Substance Inventory	86,228 (79%)	Registration numbers, chemical name, regulatory flags, UVCB flag, commercial status...
		Chemical Data Reporting	8,707 (92%)	Registration numbers, chemical name, activity, product information, consumer and industrial use...
Oceania	Australia	Australian Inventory of Chemical Substances (AICS)	40,348 (99%)	Registration numbers, chemical name, molecular formula, conditions of use...
	New Zealand	New Zealand Inventory of Chemicals (NZIoC)	28,712 (100%)	Registration numbers, chemical name, approval status.

Acronyms

Units

Unit	Full Name
mn	Million (106)
bn	Billion (109)
tn	Trillion (1012)
pa	Per annum

Terms

Acronym	Full Name	Description
GHG	Greenhouse gas	These are gases, such as carbon dioxide, that prevent heat from escaping the atmosphere, and therefore have a warming effect on the planet.[159]
PB	Planetary boundary	Theoretical limits within which humanity can continue to develop with a greatly reduced risk of large-scale abrupt or irreversible environmental changes.[160]
SDG	Sustainable development goal	A set of 17 international goals, made up of 169 targets, which call for all countries to contribute to, for instance, ending poverty, hunger, reducing inequality while tackling climate change and preserving forests and oceans.[161]

Disclaimer

As an initiative of Tracker Group Ltd., Planet Tracker's reports are impersonal and do not provide individualised advice or recommendations for any specific reader or portfolio. Tracker Group Ltd. is not an investment adviser and makes no recommendations regarding the advisability of investing in any particular company, investment fund or other vehicle. The information contained in this research report does not constitute an offer to sell securities or the solicitation of an offer to buy, or recommendation for investment in, any securities within any jurisdiction. The information is not intended as financial advice.

The information used to compile this report has been collected from a number of sources in the public domain and from Tracker Group Ltd. licensors. While Tracker Group Ltd. and its partners have obtained information believed to be reliable, none of them shall be liable for any claims or losses of any nature in connection with information contained in this document, including but not limited to, lost profits or punitive or consequential damages. This research report provides general information only. The information and opinions constitute a judgment as at the date indicated and are subject to change without notice. The information may therefore not be accurate or current. The information and opinions contained in this report have been compiled or arrived at from sources believed to be reliable and in good faith, but no representation or warranty, express or implied, is made by Tracker Group Ltd. as to their accuracy, completeness or correctness and Tracker Group Ltd. does also not warrant that the information is up-to-date.

References

1 Steffen, W., Richardson, K., Rockström, J., Cornell, S.E., Fetzer, I., Bennett, E.M., Biggs, R., Carpenter, S.R., de Vries, W., de Wit, C.A., Folke, C., Gerten, D., Heinke, J., Mace, G.M., Persson, L.M., Ramanathan, V., Reyers, B., Sörlin, S. (2015) **Planetary Boundaries: Guiding Human Development on a Changing Planet.** Science. Available here.

2 Richardson, K., Steffen, W., Lucht, W., Bendtsen, J., Cornell, S. E., Donges, J. F., Drüke, M., Fetzer, I., Bala., G. von Bloh, W., Feulner, G., Fiedler, S., Gerten, D., Gleeson, T., Hofmann, M., Huiskamp, W., Kummu, M., Mohan, C., Nogués-Bravo, D., Petri, S., Porkka, M., Rahmstorf, S., Schaphoff, S., Thonicke, K., Tobian, A., Virkki, V., Wang-Erlandsson, L., Weber, L., Rockström, J. (2023) **Earth beyond six of nine planetary boundaries**. Science Advances, 9 (37) Available here.

3 Rockström, J., Steffen, W., Noone, K., Persson, A., Chapin III, F. S., Lambin, E. F., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., de Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R. W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., Foley, J. A. (2009) **Planetary Boundaries: Exploring the Safe Space for Humanity**. Ecology and Society. Available here.

4 Merkl, A., Charles, D. (2022) The Price of Plastic Pollution: Social Costs and Corporate Liabilities, Minderoo Foundation. Available here.

5 CAS (2024) **CAS Content**. Chemical Abstracts Service. Available here. Accessed on [2024-05-17]

6 UNEP (2019) **Global Chemicals Outlook II. From Legacies to Innovative Solutions: Implementing the 2030 Agenda for Sustainable Development**. United Nations Environment Programme. Available here.

7 Wang, Z., Walker, G.W., Muir, D.C.G, Nagatani-Yoshida, K. (2020) **Toward a Global Understanding of Chemical Pollution: A First Comprehensive Analysis of National and Regional Chemical Inventories**. Environmental Science and Technology. Available here.

8 EEA (2024) **Managing the Systemic Use of Chemicals in Europe**. European Environment Agency. Available here. Accessed on [2024-07-18]

9 Persson, L., Carney Almroth, B.M., Collins, C.D., Cornell, s., de Wit, C.A., Diamond, M.L., Fantke, P., Hassellöv, M., MacLeod, M., Ryberg, M.W., Søgaard Jørgensen, P., Villarrubia-Gómez, P., Wang, Z., Zwicky Hauschild, M. (2022) **Outside the Safe Operating Space of the Planetary Boundary for Novel Entities**. Environmental Science and Technology. Available here.

10 European Commission (2024) **The European Pollutant Release and Transfer Register (E-PRTR)**. Available here.

11 US EPA (2024) **About the TSCA Chemical Substance Inventory**. United States Environmental Protection Agency. Available here. Accessed on [2024-05-21]

12 US EPA (2024) **TRI Listed Chemicals**. United States Environmental Protection Agency. Available here. Accessed on [2024-03-21]

13 SABIC (2024) S**ABIC Integrated Annual Report 2023**. Available here. Accessed on [2024-08-05]

14 UNEP (2024) **About the Montreal Protocol**. United Nations Environment Programme. Available here. Accessed on [2024-08-05]

15 UNEP Ozone Secretariat (2020) **The Evolution of the Montreal Protocol**. United Nations Environment Programme. Available here. Accessed on [2024-08-05]

16 UNEP (2024) **Global Framework on Chemicals**. United Nations Environment Programme. Available here. Accessed on [2024-06-17]

17 UNEP (2020) **The Strategic Approach to International Chemicals Management (SAICM)**. United Nations Environment Programme. Available here. Accessed on [2024-07-18]

18 UNEP (2019) **Stockholm Convention Overview**. United Nations Environment Programme. Available here. Accessed on [2024-07-18]

19 UNEP (2019) **Rotterdam Convention Overview**. United Nations Environment Programme. Available here. Accessed on [2024-07-18]

20 Convention on Biological Diversity (2024) **The Biodiversity Plan for Life on Earth. 2030 Targets**. Available here. Accessed on [2024-03-21]

21 Planet Tracker (2022) UNEP: **Undertaking Negotiations to Eliminate Plasticization**. Available here

22 Planet Tracker (2023) **What financial markets should take away from the latest round of negotiations towards a Global Plastic Pollution Treaty**. Available here

23 Planet Tracker (2023) **Global Plastics Treaty headwinds**. Available here

24 Planet Tracker (2023) **Negotiations for a Global Plastic Pollution Treaty (INC-3) – Insights for Financial Institutions**. Available here

25 Planet Tracker (2024) **The Global Plastic Pollution Treaty negotiations – what financial institutions should watch out for....** Available here

26 Planet Tracker (2024) **What financial institutions should take away from the 4th round of Global Plastics Treaty negotiations**. Available here

27 UNEP (2024) **Intergovernmental Negotiating Committee on Plastic Pollution**. United Nations Environment Programme. Available here. Accessed on [2024-06-17]

28 UNEP (2024) **Ad Hoc Intersessional Open-ended Expert Groups**. United Nations Environment Programme. Available here. Accessed on [2024-06-17]

29 Wang-Erlandsson, L., Tobian, A., van der Ent., R.J., Fetzer, I., te Wierik, S., Porkka, M., Staal, A., Jaramillo, F., Dahlmann, H., Singh, C., Greeve, P., Gerten, D., Keys, P.W., Gleeson, T., Cornell, S.E., Steffen, W., Bai, X., Rockstrom, J. (2022) **A Planetary Boundary for Green Water**. Nature Reviews Earth and Environment. Volume 3. Available here.

30 Global Tipping Points (2024) **Global Tipping Points Report**. University of Exeter's Global Systems Institute. Available here. Accessed [2024-08-05]

31 Raworth, K. (2012) **A Safe and Just Space for Humanity. Can we live within the doughnut?** Oxfam. Available here.

32 UNEP (2020) **Safer use of chemicals can help protect biodiversity**. United Nations Environment Programme. Available here. Accessed on [2024-08-08]

33 WHO (2021) **The Public Health Impact of Chemicals: Knowns and Unknowns**. World Health Organisation. Available here.

34 Zalasiewicz, J., Waters, C.N., Ivar do Sul, J.A., Corcoran, P.L., Barnosky, A. D., Cearreta, A., Edgeworth, M., Gałuszka, A., Jeandel, C., Leinfelder, R., McNeill, J.R., Steffen, W., Summerhayes, C., Wagreich, M., Williams, M., Wolfe, A.P., Yonan Y. (2016) **The geological cycle of plastics and their use as a stratigraphic indicator of the Anthropocene**. Available here.

35 Grandjean, Bellanger (2017) **Calculation of the disease burden associated with environmental chemical exposures: application of toxicological information in health economic estimation**. Available here.

36 Minderoo Foundation (2022) **The Price of Plastic Pollution. Social Costs and Corporate Liabilities**. Available here.

37 Bloomberg (2024) **Bloomberg Terminal**.

38 UNEP (2015) **Global Waste Management Outlook**. United Nations Environment Programme. Available here.

39 Food Standards Agency (2024) **BPA in Plastic**. Available here.

40 Cimmino, I., Fiory, F., Perruolo, G., Miele, C., Beguinot, F., Formisano, P., Oriente, F. (2020) **Potential Mechanisms of Bisphenol A (BPA) Contributing to Human Disease**. International Journal of Molecular Sciences, 21. Available here.

41 Rillig, M.C., Kim, S.W., Kim, T.Y., Waldman, W.R. (2021) **The Global Plastic Toxicity Debt**. Environmental Science & Technology. Available here.

42 Planet Tracker (2024) **Major Investors Sign up To Address Plastic Pollution**. Available here.

43 Planet Tracker (2023) Investors need to ensure that risks associated with plastic are adequately priced. Available here. Accessed on [2024-06-17]

44 Diamond, M.L., de Wit, C.A., Molander, S., Scheringer, M., Backhaus, T., Lohmann, R., Arvidsson, R., Bergman, A., Hauschild, M., Holoubek, I., Persson, L., Suzuki, N., Vighi, M., Zetzsch, C. (2015) **Exploring the planetary boundary for chemical pollution**. Environment International. Available here.

45 Ryberg, M. W., Hauschild, M.Z., Wang, F., Averous-Monnery, S., Laurent, A. (2019) **Global environmental losses of plastics across their value chains**. Resources, Conservation and Recycling. Available here.

46 Kvale, K., Prowe, A.E.F., Chien, CT., Landolfi, A., Oschlies, A. (2020) **The global biological microplastic particle sink**. Scientific Reports. Available here.

47 Worm, B., Lotze, H.K., Jubinville, I., Wilcox, C., Jambeck, J. (2017) **Plastic as a Persistent Marine Pollutant**. Annual Review of Environment and Resources. Available here.

48 Landrigan, P.J., Raps, H., Cropper, M., Bald, C., Brunner, M., Maya Canonizado, E., Charles, D., Chiles, T.C., Donohue, M.J., Enck, J., Fenichel, P., Fleming, L.E., Ferrier-Pages, C., Fordham, R., Gozt, A., Griffin, C., Hahn, M.E., Haryanto, B., Hixson, R., Ianelli, H., James, B.D., Kumar, P, Laborde, A., Lavender Law, K., Martin, K., Mu, J., Mulders, Y., Mustapha, A., Niu, J., Pahl, S., Park, Y., Pedrotti, M.L., Avery Pitt, J., Ruchirawat, M., Seewoo, B.J., Spring, M., Stegeman, J.J., Suk, W., Symeonides, C., Takada, H., Thompson, R.C., Vicini, A., Wang, Z., Whitman, E., Wirth, D., Wolff, M., Yousuf, A.K. (2023) **The Minderoo-Monaco Commission on Plastics and Human Health**. Annals of Global Health. Available here

49 Posthuma, L., van Gils, J., Zijp, M.C., van de Meent, D., de Zwartd, D. (2018) **Species Sensitivity Distributions for Use in Environmental Protection, Assessment, and Management of Aquatic Ecosystems for 12 386 Chemicals**. Environmental Toxicology and Chemistry. Available here.

50 MacLeod, M., Breitholtz, M., Cousins, I.T., de Wit, C.A., Persson, L.M., Ruden, C., McLachlan, M.S. (2014) **Identifying Chemicals That Are Planetary Boundary Threats**. Environmental Science & Technology. Available here.

51 Leclerc, A., Berthet, E., Stadler, K., Wood, R., Laurent, A. (2023) **Toward global and national toxicity footprints**. Journal of Industrial Ecology. Available here.

52 Planet Tracker (2023) **Toxic Footprints Europe**. Available here.

53 Planet Tracker (2022) **Toxic Footprints USA**. Available here.

54 Reuters (2024) **US Supreme Court blocks EPA's 'Good Neighbor' air pollution plan**. Available here. Accessed on [2024-09-03]

55 US EPA (2024) **Good Neighbor Plan for 2015 Ozone NAAQS**. United States Environmental Protection Agency. Available here. Accessed on [2024-09-03]

56 Muir, D.C.G., Getzinger, G.J., McBride, M., Ferguson, P.L. (2023) **How Many Chemicals in Commerce Have Been Analyzed in Environmental Media? A 50 Year Bibliometric Analysis**. Environmental Science and Technology. Available here.

57 CPCB (2008) **Inventory of Hazardous Chemicals Import in India**. Central Pollution Control Board. Available here. Accessed on [2024-03-26]

58 ECHA (2024) **Pre-registered substances**. European Chemicals Agency. Available here. Accessed on [2024-03-26]

59 EEA (2023) **Managing the systemic use of chemicals in Europe**. Available here. Accessed on [2024-07-03]

60 Food and Drug Administration (2014). **Bisphenol A (BPA): Use in food contact application**. Available here.

61 EFSA (2023) **Bisphenol A.** Available here.

62 Environmental Working Group (2015) **BPA in canned food**. Available here.

63 The Independent (2012) **Major producers to ditch BPA from packaging**. Available here.

64 ECHA (2024) **Per- and polyfluoroalkyl substances (PFAS)**. European Chemicals Agency. Available here. Accessed on [2024-03-25]

65 EC (2024) **Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on Persistent Organic Pollutants**. European Commission. Available here. Accessed on [2024-03-26]

66 Patagonia (2024) **Made without PFCs / PFAS**. Available here.

67 Apple (2022) **Apple's commitment to phasing out per- and polyfluoroalkyl substances (PFAS)**. Available here.

68 BASF (2021) **Annual Report**. Available here.

69 BASF (2022) **Annual Report**. Available here.

70 BASF (2023) **Annual Report**. Available here.

71 US EPA (2023) **Toxics Release Inventory**. United States Environmental Protection Agency. Available here.

72 LyondellBasell (2023) **Form 10-K**. LyondellBasell Industries N.V.

73 Bayer Global (2024) **Bayer Capital Markets Day 2024**. Available here

74 ChemSec (2024) **SIN List – Substitute It Now**. Available here

75 Planet Tracker (2024) I**s Bayer a litigation leading indicator?** Available here.

76 New York Times (2023) 3M Reaches $10.3 Billion Settlement in 'Forever Chemicals' Suits. Accessed on [2024-09-18] Available here.

77 Associated Press (2023) 3M reaches $10.3 billion settement over contamination of water systems with 'forever chemicals'. Accessed on [2024-09-18]. Available here.

78 3M (2024) 3M Settlement with Public Water Suppliers to Address PFAS in Drinking Water Receives Final Court Approval. Accessed on [2024-09-18]. Available here.

79 New York Times (2023) Three 'Forever Chemicals' Makers Settle Public Water Lawsuits. Accessed on [2024-09-18]. Available here.

80 The European Chemical Industry Council, AISBL (2023) **The European Chemical industry. A vital part of Europe's Future. Facts and Figures 2023**. Available here.

81 The European Chemical Industry Council, AISBL (2023) **The European Chemical industry. A vital part of Europe's Future. Facts and Figures 2023**. Available here.

82 The European Chemical Industry Council, AISBL (2023) **The European Chemical industry. A vital part of Europe's Future. Facts and Figures 2023**. Available here.

83 NAICS Association (2024) **NAICS Code Description. 31-33 Manufacturing**. Available here. Accessed on [2024-05-17]

84 EFPIA (2023) **Socio Economic Analysis of the potential restriction of the per- and polyfluoroalkyl substances (PFAS) used in the production, packaging and delivery of human medicinal products**. European Federation of Pharmaceutical Industries and Associations. Available here. Accessed on [2024-05-26].

85 European Commission (2015) **Commission Implementing Regulations (EU) 2015/1295 of 27 July 2015 approving the active substance sulfoxaflor, in accordance with Regulation (EC) No 1107/2009 of the European Parliament and of the Council concerning the placing of plant protection products on the market, and amending the Annex to Commission Implementing Regulation (EU) No 540/2011**. Available here.

86 Pan Europe (2022) **European Commission bans bee-toxic sulfoxaflor insecticide: one less bee-killing neonicotinoid in the EU**. Available here.

87 Wilkinson, J. L. et al (2022) **Pharmaceutical pollution of the world's rivers**. Available here.

88 Sobek, Bejgarn, Rudén, Breitholtz (2016) **The dilemma in prioritizing chemicals for environmental analysis: known versus unknown hazards**. Available here.

89 The Guardian (2023) **New 'forever chemicals' polluting water near North Carolina plant, study finds**. Available here. Accessed on [2024-05-17]

90 von Borries, Holmquist, Kosnik, Beckwith, Jolliet, Goodman, Fantke (2023) **Potential for Machine Learning to Address Data Gaps in Human Toxicity and Ecotoxicity Characterization**. Available here.

91 European Commission (2022) **Restrictions Roadmap under the Chemicals Strategy for Sustainability**. Available here.

92 OECD (2021) **Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance**. Organisation for Economic Co-operation and Development. Available here.

93 C&EN (2024) **A guide to the PFAS found in our environment. Chemical and Engineering News**. Available here. Accessed on [2024-03-22]

94 Evich, M.G., Davis, M.J.B., McCord J.P., Acrey, B., Awkerman, J.A., Knappe, D.R.U., Lindstrom, A.B., Speth, T.F., Tebes-Stevens, C., Strynar, M.J., Wang, Z., Weber, E.J., Henderson, W.M., Washington, J.W. (2022) **Per- and Polyfluoroalkyl Substances in the Environment**. Science. Available here.

95 US EPA (2024) **PFAS Analytic Tools**. United States Environmental Protection Agency. Available here. Accessed on [2024-09-02]

96 Paul, A.G., Jones, K.C., Sweetman, A.J. (2008) **A First Global Production, Emission, And Environmental Inventory For Perfluorooctane Sulfonate**. Environmental Science and Technology. Available here.

97 Garnett, J., Halsall, C., Vader, A., Joerss, H., Ebinghaus, R., Leeson, A., Wynn, P.M. (2021) **High Concentrations of Perfluoroalkyl Acids in Artic Seawater Driven by Early Thawing Sea Ice**. Environmental Science and Technology. Available here.

98 EWG (2024) **Global danger: Wildlife at risk from PFAS exposure**. Environmental Working Group. Available here.

99 Le Monde (2023) **'Forever pollution': Explore the map of Europe's PFAS contamination**. Available here. Accessed on [2024-03-25]

100 Cousins, I.T., Johansson, J.H., Salter, M.E., Sha, B., Scheringer, M. (2022) **Outside the Safe Operating Space of a New Planetary Boundary for Per- and Polyfluoroalkyl Substances (PFAS)**. Environmental Science and Technology. Available here.

101 Brendel, S. Fetter, E., Staude, C., Vierke, L., Biegel-Engler, A. (2018) **Short-chain perfluoroalkyl acids: environmental concerns and a regulatory strategy under REACH**. Environmental Sciences Europe. Available here.

102 EC (2024) **REACH Regulation. To protect human health and the environment against the harmful effects of chemical substances**. European Commission. Available here. Accessed on [2024-03-25]

103 ING (2024) **Agriculture can obviously do anything**. Available here. Accessed on [2024-03-11]

104 Bayer CropScience Limited (2024) **Propulse. Fungicide Product Label**. Available here. Accessed on [2024-03-25]

105 Bayer CropScience Limited (2024) **Othello. Herbicide Product Label**. Available here. Accessed on [2024-03-27]

106 Bayer CropScience Limited (2024) **Liberator. Herbicide Product Label**. Available here. Accessed on [2024-03-27]

107 Bayer (2021) **Bayer Further Commits to Crop Protection Innovation with Planned Introduction of Diflufenican**. Available here. Accessed on [2024-03-27]

108 DEP NJ (2024) **Solvay West Deptford Plant PFAS Settlement**. Department of Environmental Protection New Jersey. Available here. Accessed on [2024-05-16]

109 Solvay (2019) **S1 2019 Earnings Call Transcript**. Available here.

110 Solvay (2021) **Q1 2021 Earnings Call Transcript**. Available here.

111 Solvay (2022) **Q3 2022 Earnings Call Transcript**. Available here.

112 Solvay (2023) **S1 2023 Earnings Call Transcript**. Available here.

113 Superior Court of New Jersey (2024) **DOCKET NO. GLO-L-001239-20. Civil Action. Judicial Consent Oder**. Available here. Accessed on [2024-05-16]

114 Solvay (2023) **Q4 2022 Earnings Call Transcript**. Available here.

115 Solvay (2022) **S1 2022 Earnings Call Transcript**. Available here.

116 US EPA (2024) **Addition of Certain PFAS to the TRI by the National Defense Authorization Act**. United States Environmental Protection Agency. Available here.

117 Arp, H. P., Kühnel D., Rummel C., MacLeod M., Potthoff A., Reichelt S., Rojo-Nieto E., Schmitt-Jansen M., Sonnenberg J., Toorman E., and Jahnke A. (2021) **Weathering Plastics as a Planetary Boundary Threat: Exposure, Fate, and Hazards**. Environmental Science & Technology. Available here.

118 UNEP (2024) O**ur planet is choking on plastic**. United Nations Environmental Programme. Available here. Accessed on [2024-05-16]

119 Planet Tracker (2024) **Plastic Recycling Deception**. Available here.

120 Kane, I. A., Fildani, A. (2021) **Anthropogenic pollution in deep-marine sedimentary systems—A geological perspective on the plastic problem**. Available here.

121 Galgani, L., Beiras, R., Glagani, F., Panti, C. And Borja, A. (2019) **Editorial: Impacts of Marine Litter**. Available here.

122 Meijer, L. J. J., van Emmerik, T., van der Ent, R., Schmidt, C., Lebreton, L. (2021) **More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean**. Available here.

123 Break Free From Plastic (2022) **Brand Audit Report 2018-2022**. Available here.

124 Rochman, C. M.; Browne, M. A.; Underwood, A. J.; van Franeker, J. A.; Thompson, R. C.; Amaral-Zettler, L. A. **The Ecological Impacts of Marine Debris: Unraveling the Demonstrated Evidence from What Is Perceived**. Ecology 2016, 97 (2), 302−312. Available here.

125 Li, Y., Tao, L., Wang, Q., Wang, F., Li, G., Song, M. (2023) **Potential Health Impact of Microplastics: A Review of Environmental Distribution, Human Exposure, and Toxic Effects**. Environment & Health. Available here.

126 Allen, S., Allen, D., Karbalaei, S., Maselli, V., Walker, T. R. (2022) **Micro(nano)plastics sources, fate, and effects: What we know after ten years of research**. Available here.

127 M&C Saatchi Group (2023) **Minderoo Foundation: The Plastic Forecast**. Available here. Accessed [2024-08-05]

128 Wagner, M., Monclús, L., Arp, H.P.H., Groh, K.J., Løseth, M.E., Muncke, J., Wang, Z., Wolf, R., Zimmermann, L. (2024) **State of the science on plastic chemicals - Identifying and addressing chemicals and polymers of concern**. Available here.

129 BBVA (2022) **Sustainable Debt Financing Framework**. Banco Bilbao Vizcaya Argentaria. Available here

130 ING (2022) **Climate Report**. Available here.

131 Intesa SanPaolo (2022) **Green, Social and Sustainability Bond Framework**. Available here.

132 HSBC (2020) **Annual Report and Accounts**.

133 Danske Bank (2021) **Sustainability Report**. Available here.

134 Standard Chartered Bank (2022) **Sustainability Bond Framework. Evaluation Summary**. Available here.

135 American Chemistry Council (2023) **2023 Guide to the Business of Chemistry**. Available here.

136 Planet Tracker (2024) **Unilever's 2024 Climate Transition Update**. Available here.

137 Unilever (2020) **CDP Climate Change Questionnaire**.

138 Unilever (2023) **Annual Report and Accounts 2022**.

139 S&P Global (2024) **Pesticides Market Analysis**. Available here. Accessed on [2024-06-26]

140 UNEP (2024) **Highly Hazardous Pesticides (HHPs)**. United Nations Environment Programme. Available here. Accessed on [2024-06-26]

141 Skendžic, S., Zovko, M., Živkovic, I.P., Lešic, V., Lemic, D. (2021) **The Impact of Climate Change on Agricultural Insect Pests.** Insects. Available here.

142 ShareAction (2023) **Pesticides: A Growing Problem. Why investors must engage with the pesticides industry**. Available here.

143 Public Eye (2020) **Banned in Europe: How the EU exports pesticides too dangerous for use in Europe**. Available here. Accessed on [2024-06-20]

144 Bayer CropScience (2024) **Roundup Ready Corn 2**. Available here. Accessed on [2024-06-20]

145 Bayer CropScience (2022) **Roundup Xtend 2Herbicide with VaporGrip Technology and XtendiMax 2 Herbicide with VaporGrip Technology – Label Overview**. Available here. Accessed on [2024-06-20]

146 Corteva (2024) **Product Use Guide. Enlist Herbicides – Used with Enlist E3 Soybeans, Enlist Cotton and Enlist Corn**. Available here.

147 Syngenta (2019) **HalexGT Corn Herbicide**. Available here.

148 BASF (2020) **Trait and Technology Use Manual**. Available here.

149 Seeger Weiss (2017) S**yngenta Genetically Modified Seeds Settlement**. Available here. Accessed on [2024-06-21]

150 FAO (2021) **Assessment of agricultural plastics and their sustainability. A call for action**. Available here.

151 Ritchie, H. (2018) **FAQs on Plastics**. Available here. Accessed on [2024-07-03]

152 Phelan, A., Meissner, K., Humphrey, J., Ross, H. (2022) **Plastic pollution and packaging: Corporate commitments and actions from the food and beverage sector**. Journal of Clear Production. Available here.

153 Bingler, J.A., Kraus, M., Leippold, M., Webersinke, N. (2024) **How cheap talk in climate disclosures relates to climate initiatives, corporate emissions, and reputation risk**. Journal of Banking and Finance. Available here.

154 GORE-TEX (2024) **Capturing the Value of Fluoromaterials While Reducing Their Impact**. Available here. Accessed on [2024-06-25]

155 IPEN (2022) **PFAS in Clothing. Study in Indonesia, China, and Russia shows Barriers for Non-Toxic Circular Economy**. International Pollutants Elimination Network. Available here.

156 Danish EPA (2015) P**olyfluoroalkyl Substance (PFASs) in Textiles for Children**. The Danish Environmental Protection Agency. Ministry of Environment and Food. Available here.

157 Haley Aldrich (2021) **Textile Manufacturing and PFAS: Three Phases of Risk**. Available here. Accessed on [2024-06-25]

158 EWG (2022) **New test find toxic 'forever chemicals' in bedding, yoga pants and other textiles**. Available here. Accessed on [2024-06-25]

159 US EPA (2023) **Overview of Greenhouse Gases**. United States Environmental Protection Agency. Available here.

160 SRC (2023) **Planetary Boundaries**. Stockholm Resilience Centre. Available here. Accessed on [2023-07-19]

161 UN (2023) **The 17 Goals**. United Nations. Available here. Accessed on [2023-07-19]

ABOUT PLANET TRACKER

Planet Tracker is an award-winning non-profit financial think tank aligning capital markets with planetary boundaries. Created with the vision of a financial system that is fully aligned with a net-zero, resilient, nature positive and just economy well before 2050, Planet Tracker generates break-through analytics that reveal both the role of capital markets in the degradation of our ecosystem and show the opportunities of transitioning to a zero-carbon, nature positive economy.

PLASTIC TRACKER

The goal of Plastics Tracker is to stem the flow of environmentally damaging plastics and related-products that are creating global waste and health issues by transparently mapping capital flows and influence in the sector starting from resins production through to product use. By illuminating risks related to natural capital degradation and depletion, investors, lenders and corporate interests across the economy will be enabled to create more sustainable plastics products.

ACKNOWLEDGEMENTS

Authors: Christopher Baldock, Filippo Grassi, John Willis, Arianna Manili.

Reviewers: Planet Tracker would like to thank the academic reviewers of this report who have requested to be kept anonymous at this time.

WITH THANKS TO OUR FUNDER

Flotilla
FOUNDATION

Suggested citation: Baldock, C., Grassi, F., Willis, J., Manili, A. ***Novel Entities – a financial time bomb. Why investors need to be aware of the risks and impacts of toxic artificial chemicals****. Planet Tracker (2024).*

Planet Tracker

For further information please contact:
Nicole Kozlowski, Head of Engagement, Planet Tracker
nicole@planet-tracker.org

www.planet-tracker.org #planet_tracker