SYSTEMIQ

Breaking the Chain

Risks, regulations and roadmap for phasing out PFAS from food delivery packaging

About this report

Per- and polyfluoroalkyl substances (PFAS) – 'forever chemicals' – are widely used in food delivery packaging due to their grease and water-resistant properties. As understanding of the problems associated with PFAS grows, legislation, regulation and litigation risk are increasing. It is imperative that players in the food delivery industry take action on PFAS to safeguard the health of consumers and workers across the supply chain, minimise business disruption risk, prioritise food safety, ensure policy compliance and protect the environment.

This report outlines the fact base on PFAS use in food delivery packaging and the associated risks; assesses the regulatory landscape and its likely evolution; examines the alternatives to PFAS and the challenges to their adoption; and evaluates and shows the feasibility of a vision for a phase out of PFAS in food delivery packaging.

The report draws on insights from published research and was developed as an evidence-based perspective through close collaboration with a wide group of experts from academia, civil society and industry.

About Systemiq

Systemiq, the system-change company, was founded in 2016 to drive the achievement of the Sustainable Development Goals and the Paris Agreement by transforming markets and business models in five key systems: nature and food, materials and circularity, energy, urban areas and sustainable finance. A certified B Corp, Systemiq combines strategic advisory with high-impact, on-the-ground work; and partners with business, finance, policymakers and civil society to deliver system change.

In 2020, Systemiq and The Pew Charitable Trusts published *Breaking the Plastic Wave* (www.systemiq.earth/breakingtheplasticwave) – a first-of-its-kind model of the global plastics system that outlines how to radically reduce ocean plastic pollution. In 2022, Systemiq published *ReShaping Plastics*, setting out pathways to a circular, climate-neutral plastics system in Europe. Systemiq has also been deeply engaged in ongoing UN negotiations on a legally binding instrument to end plastic pollution, including quantifying potential impacts of different scenarios in *Towards Ending Plastic Pollution by 2040* and *Plastic Treaty Futures*.

Learn more at **www.systemiq.earth** and please contact us at **plastic@systemiq.earth.**

SYSTEMIQ

Authors and acknowledgements

Systemiq core team

Felix Cornehl, Sophie Herrmann, Paula Petersen and Emma Walsh in alphabetical order.

The authors would like to thank the following contributors and reviewers for taking the time to provide valuable comments. The contributors and their institutions do not necessarily endorse the report's findings.

Contributors

BioPak, ChemTrust, ChemSec, Food Packaging Forum, Guzman y Gomez, Kinara, National Stewardship Action and Zero Waste Europe, in alphabetical order. We are also grateful to four additional players from across the value chain, who shared their perspectives but were not comfortable to be publicly identified.

Financial support

Thank you to Uber Eats for commissioning this report and acting as a key adviser and partner. The views expressed in this report do not necessarily represent those of Uber Eats.

Design and editorial

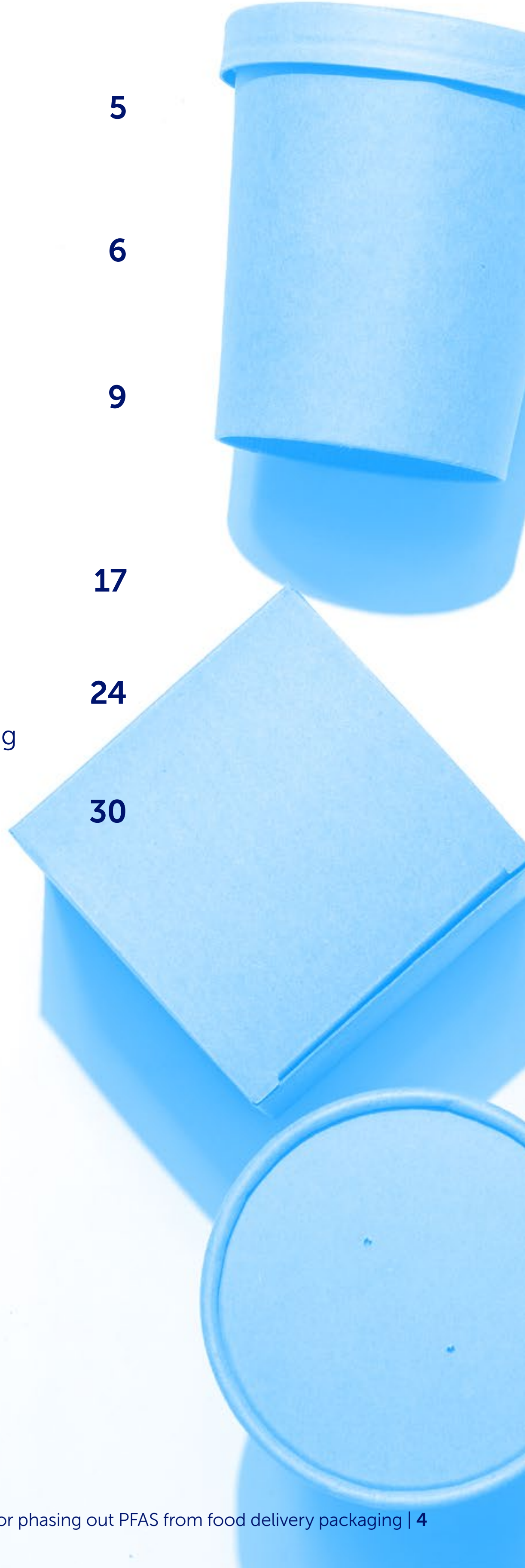
HERD and Carolyn Boyle.

Citation

If reproducing or referencing the content in this report, please use the following citation: Systemiq (2024). **Breaking the chain:** Risks, regulations and roadmap for phasing out PFAS from food delivery packaging.

Rights and permissions

Contents



Executive summary

Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals with distinctive properties thanks to the presence of carbon fluorine bonds – one of the strongest single bonds in organic chemistry. Their resistance to heat, water and oil proves useful in a wide range of products. They are commonplace in food delivery packaging, which is the focus of this report, with separate studies detecting them in up to 25% and 75% of all takeaway and delivery packaging in Australia and six European countries, respectively. While the available data is sparse, and PFAS detection is challenging, a diverse range of PFAS have been identified in a variety of formats, including moulded clamshell containers, trays, bowls and boxes.

However, the same qualities that make PFAS so useful also contribute to their persistence in the environment and bioaccumulation in living organisms, earning them the label 'forever chemicals'. The use of PFAS is thus becoming increasingly controversial as evidence links exposure to long-term effects on health and the environment. Associations have been found between certain PFAS and hormone disruption, fertility, cancer and immune disorders in humans and animals. While the diversity of PFAS and the lack of transparency on their use complicate scientific assessment, their overall impact is estimated to account for a significant share of healthcare spending and their removal from the environment at scale is practically impossible.

PFAS regulation is tightening globally in response to the growing evidence of the risks of PFAS; but it remains fragmented, with varying definitions, thresholds and approaches across markets. Some jurisdictions, such as the EU and some US states, are moving towards comprehensive bans on non-essential uses of all PFAS; others, such as the US federal government, are focusing on the partial phaseout of specific substances. Full phaseouts offer stronger consumer protection and long-term stability. While partial bans are easier for businesses to manage in the short term, they risk repeated revisions and may lead to regrettable substitutions if targeted PFAS are simply replaced with other PFAS. The lack of harmonisation across markets is increasing the compliance burden, making greater clarity and collaboration desirable.

The phaseout of PFAS in food delivery packaging is challenging but feasible. Companies like 3M, Decent Packaging, and Guzman y Gomez, along with initiatives such as ChemSec's 'No to PFAS' and APCO's 'Phase Out Plan,' set a precedent across the value chain. However, businesses face three key challenges: identifying areas for substitution, selecting safer alternatives, and implementing these alternatives effectively. Supply chain opacity is a major barrier, as upstream players often treat chemical content as confidential. Selecting safer alternatives should follow the waste hierarchy, avoiding unnecessary uses or deploying alternative models (e.g., reuse) where possible. Substitute materials are available at a premium, currently amounting to between zero and 10 percent. Additional challenges include the lack of standardised definitions and testing, as well as trade-offs between cost, functionality, and sustainability, and the need for manufacturers to modify processes.

The proactive phaseout of PFAS from food delivery packaging is a prudent step for businesses to take control of the transition and mitigate regulatory, operational and reputational risks. Acting now will enable them to stay ahead of future changes, minimise disruption and advocate for systemic shifts to scale sustainable alternatives. **Efficient and rapid phase out relies on policymakers to catalyse industry action and level the playing field** by providing clear definitions, regulatory certainty and targeted incentives. Global harmonisation efforts, e.g., through the Stockholm Convention, can further accelerate progress. Together, these efforts will drive a safer and more sustainable future food delivery system.

Chapter 1

Introduction to PFAS, their use in food delivery packaging and the associated impacts

1.1 Uses of PFAS

Per- and poly-fluoroalkyl substances (PFAS) are a group of synthetic chemicals whose unique properties have widespread applications. These chemicals are characterised by the presence of carbon-fluorine bonds (see Box A), one of the strongest bonds in organic chemistry, which afford remarkable chemical and thermal stability and water and oil resistance. The best-known PFAS, Teflon, was also the first to be discovered, in 1938. Since the 1940s, PFAS have been used in a diverse range of commercial, medical and industrial products, including firefighting foams, waterproof clothing, paint and non-stick cookware.

The same properties that make PFAS so useful also contribute to their problematic persistence, bioaccumulation and mobility. Labelled 'forever chemicals', PFAS do not break down easily, remaining in the environment and living organisms for extended periods. Their half-lives vary widely: some non-polymeric PFAS (banned under UN conventions) have half-lives of two to eight years in the human body and even longer in soil and water.[1] PFAS also bioaccumulate, leading to increased concentrations higher up the food chain, including in humans (see Chapter 1.3).[2] Their high mobility has made PFAS ubiquitous: the chemicals frequently exceed the US EPA's drinking water thresholds and they have been detected in places as remote as Antarctica and the Marianas Trench; in hundreds of animal and plant species; and in a variety of human tissues, including umbilical cord blood and breastmilk.[3, 4, 5]

Box A: Defining PFAS

There is no universally accepted definition of 'PFAS', and estimates of the number of PFAS in circulation range from hundreds to more than 10,000.[6, 7] The widely used OECD (2021) definition describes them as 'fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any hydrogen, chlorine, bromine, or iodine atom attached)'.[8] Other definitions exclude various sub-classes of fluorinated compounds based on different criteria. PFAS can be segmented by various characteristics, including their polymeric nature and chain length[i].

i Other characteristics include the presence of functional groups (e.g., carboxylic acids) and chain fluorination.

1.2 Use of PFAS in food delivery packaging

Food delivery packaging[ii] is just one of over 200 identified applications of PFAS, spanning more than 20 sectors[9]. Reliable data on the use of PFAS is sparse, but one estimate suggests that food packaging accounts for 15% of PFAS use by volume.[10] PFAS have been detected in as much as 75% of the typical disposable food packaging in six European countries and over 25% in Australia, including packaging from popular food delivery chains.[11, 12]

Different PFAS are added to food delivery packaging to serve various functions, although the lack of supply chain transparency makes it difficult to determine which PFAS are used for which specific purposes. PFAS are commonly added to fibre- and plant-based packaging as a coating or additive to create a chemical barrier to water, oil and grease[iii]. PFAS are also used in packaging manufacturing processes as coating agents or lubricants: for example, fluoropolymers are known to be used as lubricants in polymer extrusion processes.

1.3 Negative impacts of PFAS

PFAS enter human, animal and plant tissues and the environment through multiple exposure pathways. Certain workers (e.g., firefighters) and communities close to sites that manufacture and use PFAS face higher risks through direct contact.[13] Consumer products such as food packaging, cookware and textiles also result in everyday exposure.[14] In the case of food packaging, migration of PFAS varies depending on the amount and type of PFAS used, type of food, contact time and temperature.[15] PFAS can also leach from landfilled, incinerated, recycled or composted waste into the environment, leading to long-term contamination.[16] Once in the environment, PFAS spread through water, soil, air and food systems.

Scientific research suggests that certain PFAS can cause multiple adverse health and environmental outcomes, which are costly to society. Long-term exposure to various compounds has been linked to serious health issues, including hormone disruption, reduced fertility, developmental problems, elevated cholesterol, certain cancers and immune system damage.[17, 18, 19, 20, 21, 22, 23, 24] Studies have also linked maternal PFAS exposure to pregnancy risks such as lower birth weight and pre-eclampsia, as well as long-term health issues for children, including obesity and heart disease.[25, 26, 27]

Box B: The C8 Health Project

The C8 Health Project was a groundbreaking epidemiological study on the health impacts of PFAS. The evidence it produced of a highly probable link between C8 – a chemical used in Teflon – and population-level health conditions, including cancers, was developed and served as the basis for a class action lawsuit[iv] brought against DuPont by local citizens living in the vicinity of its Ohio manufacturing facility. As a result of this and subsequent lawsuits DuPont agreed to pay hundreds of millions of dollars in multiple settlements, and on health monitoring and community support. The story was dramatised in the 2019 *Dark Waters*.

[ii] This report primarily addresses food delivery packaging. However, the report includes mentions of "food packaging" in cases where studies and regulatory frameworks pertain to food packaging in a broader context, encompassing items such as takeaway containers and supermarket food packaging.
[iii] PFAS known to be used as barrier coatings include: short-chain fluorotelomers in grease-resistant cardboard (e.g., pizza boxes) and moulded fibre (e.g., clamshell containers).
[iv] Leach v EI du Pont de Nemours and Company.

While less is known about the environmental and ecological effects of PFAS, the available data is also concerning.[28] Aquatic ecosystems are particularly vulnerable, as PFAS persist in water and accumulate in fish and other marine life, disrupting reproductive cycles and harming biodiversity. On land, PFAS can accumulate in plants and animals, posing risks to the broader food chain. The persistence and mobility of PFAS make them difficult to contain or remediate once contamination occurs.

The financial burden of PFAS contamination is thought to be vast. Although research on the topic remains limited, two frequently cited estimates offer insight into the scale of the issue. In the US, estimated healthcare costs related to PFAS exposure range from $37–$59 billion per year – 0.9%-1.4% percent of US healthcare expenditure in 2023.[29,] In the European Economic Area, a broader assessment of annual health and environmental costs due to PFAS contamination yielded estimates of €52–€84 billion, accounting for 4%–7% of EU healthcare expenditure.[30] Projected remediation costs are in the trillions of dollars, underscoring the impracticality of fully addressing the contamination generated thus far. Legal settlements such as DuPont and Chemours' $670 million payout based on the C8 Health Project (see Box B) and 3M's $10.3 billion settlement[V] to support remediation of drinking water supplies starkly illustrate the financial liabilities facing industries that use PFAS.[31]

[V] 3M did not admit liability, and said the money will help support remediation at public water systems that detect PFAS "at any level".

Regulatory landscape and implications for business

2.1 PFAS regulation is tightening around the world, but remains fragmented

PFAS regulation is tightening around the world and food packaging is increasingly being targeted at the global, multilateral, national and state levels. The first restrictions specific to food packaging were introduced in 2009 under the Stockholm Convention (see Box C), constraining the use of certain PFAS in food contact materials. Since then, numerous jurisdictions have introduced regulations covering a wider range of PFAS –sometimes on short timescales[vi], making implementation challenging for players across the value chain (see Chapter 3).

[vi] For example, Denmark allowed 10 months for implementation of the phaseout of PFAS in food contact paper and board materials.

[vii] Perfluorooctanoic Acid (PFOA) is a long-chain perfluorinated PFAS with molecular structure $CF_3(CF_2)_6COOH$. It is one of the most studied and regulated of all PFAS today; Perfluorooctane sulfonic acid (PFOS) is a non-polymeric, long-chain PFAS, characterized by its fully fluorinated carbon chain and sulfonic acid group; Perfluorohexane sulfonic acid (PFHxS) is a non-polymeric, long-chain PFAS with a six-carbon fully fluorinated backbone and a sulfonic acid group.

[viii] Of 196 UN members, 186 were parties to the Stockholm Convention and 165 to the Rotterdam Convention as of September 2024.

[ix] Several markets outside the EU have adopted similar regulatory frameworks to REACH, such as Brazil, South Korea and Turkey.

[x] Perfluorohexanoic acid (PFHxA) is a non-polymeric, short-chain PFAS with a six-carbon fully fluorinated chain and a carboxylic acid group.

Box C: Key multilateral PFAS regulations

The UN Stockholm and Rotterdam Conventions are the leading global instruments regulating PFAS. The former bans or restricts the production, import, export and use of three PFAS substances – PFOA, PFOS and PFHxS[vii] – while the latter introduced rules requiring countries to be notified before trading PFOS and PFOA. Today, 95% and 85% of UN member states are parties to the Stockholm and Rotterdam Conventions, respectively.[viii] The lists of chemicals under both conventions continue to evolve based on emerging evidence and the identification of new substances of concern.

The EU's flagship Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals **(REACH)** is equally significant, as it has served as a blueprint for similar instruments around the world.[ix] Today, it restricts the use of PFOA, PFOS, PFHxS and PFHxA.[x] The EU is also contemplating the introduction of a 'universal PFAS restriction' after 2025, with the ambitious vision of banning non-essential uses of all PFAS. The EU defines 'essential use' of a chemical substance as use which is deemed essential for health, safety or the functioning of society and where no safer alternatives are available.[41] While one can argue whether PFAS within food delivery packaging serves an essential function in society, a range of acceptable PFAS-free alternatives already exist. Therefore, PFAS use in this product group is widely considered to be non-essential. In contrast, when used in e.g., medical devices, PFAS often serve multiple functions (e.g., friction reduction, clot resistance, and protein resistance), making them more challenging to replace. As these devices provide critical health functions and no alternatives exist that provide the necessary technical function and performance, this would be considered an essential use case for PFAS.

Other relevant EU regulations include the Packaging and Packaging Waste Regulation **(PPWR)**, expected to be published in Autumn 2024, which will ban all PFAS in food packaging from mid-2026; and the EU **Drinking Water Directive**, which has set maximum allowable concentrations for certain PFAS in potable water since 2020.

Figure 1

PFAS regulation is gaining traction at global, regional, country and state level

UN multilateral agreements | EU-wide regulation | US federal level | US individual states

1967 (US federal level)
US Food and Drug Administration (FDA) limits certain long-chain PFAS in food packaging and food contact materials

2006 (EU-wide regulation, US federal level)
PFOS included in EU Persistent Organic Pollutants (POP) regulation

US Environmental Protection Agency (EPA) regulates PFAS under the Toxic Substances Control Act (TSCA)

2009 (UN multilateral agreements)
First PFAS (PFOS) included into UN Stockholm convention, eliminating or restricting their production, trade, and use among signatories

2013 (EU-wide regulation)
First PFAS (PFOS) included in EU REACH regulation (Registration, Evaluation, Authorisation and Restriction of Chemicals)

2018 (US individual states)
New Jersey and California set limits for certain PFAS in drinking water; Washington regulates PFAS use in firefighting foam

2019 (UN multilateral agreements, US federal level)
PFOA included in Stockholm Convention, prohibiting its production, trade, and use among signatories

US Environmental Protection Agency (EPA) issues PFAS Action Plan

2020 (EU-wide regulation, US individual states, US federal level)
Michigan, New York, Vermont, and Maine establish limits or guidance levels for PFAS in drinking water

US FDA secures agreements with manufacturers to phase out certain short-chain PFAS in food contact applications by 2024

PFAS regulated under EU drinking water directive

2023 (EU-wide regulation, UN multilateral agreements)
PFAS included into UN Rotterdam convention on chemical safety in international trade of hazardous chemicals

European Parliament adopts position to ban PFAS in food packaging under Packaging and Packaging Waste Regulation (PPWR)

European Chemicals Agency (ECHA) proposal for a 'universal PFAS restriction' (under review for entry into force after 2025)

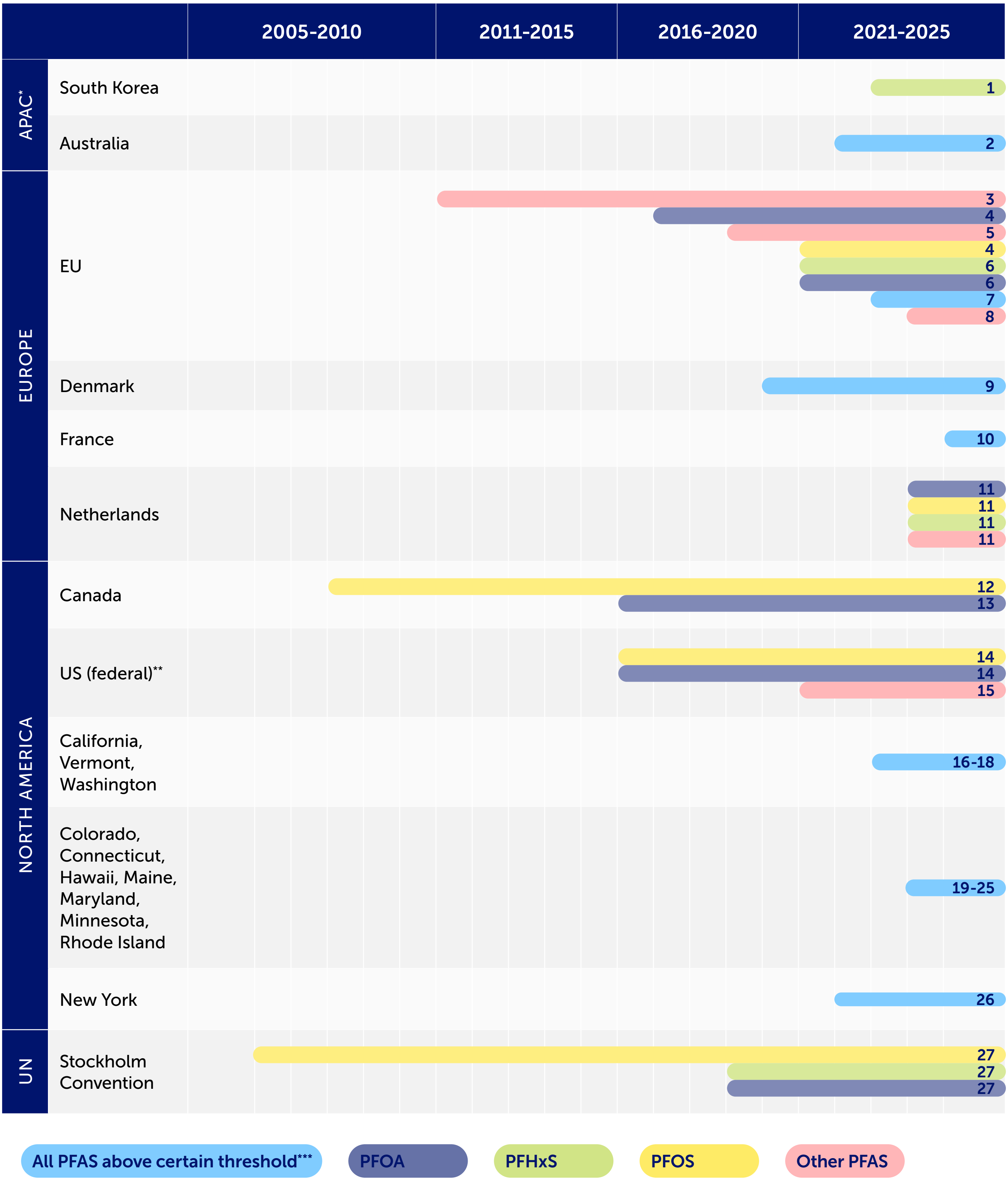
2024 (US federal level)
US EPA issues multiple PFAS restrictions (under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as well as the Safe Drinking Water Act)

2026 (EU-wide regulation)
EU POP regulation to restrict PFHxA in clothing and paper/cardboard food packaging

2028 (US individual states)
7 additional US states will introduce PFAS regulations (Washington, Minnesota, Vermont, Maryland, Colorado, Connecticut, and Hawaii)

Figure 2

Timeline of PFAS regulation in food packaging, by country, year and PFAS category



* APAC: Asia-Pacific

** Not in the graph: The US Food and Drug Administration authorized specific PFAS for use in food contact materials in 1967 (has since then been restricted – respective regulations included in graph).

*** Thresholds differ by markets - see Box D"

For details on the individual regulations see appendix and compare with relevant number.

Overall, the global regulatory landscape for PFAS remains highly fragmented, with significant divergences in terms of which PFAS are covered and how they are regulated.[xi] The specific definitions of 'PFAS' used in different regimes directly affect the number of substances that are captured by regulation. For example, the EU follows the definition adopted by the OECD (see Box A), while the US Environmental Protection Agency adopts a narrower definition that excludes fluoropolymers. The OECD definition is the most widely used worldwide; markets can define their own working scope of PFAS drawing up their own list of substances that fall within the definition. Some markets (e.g., the EU) have thus adopted a stricter scope than the OECD.[xii] Further variances between regulatory regimes include the type and level of thresholds set for PFAS (see Figure 3).

Currently, the most stringent PFAS regimes are found in industrialised markets, although regulation is also tightening in middle-income countries such as China.[xiii] The regulations introduced in industrialised markets such as Europe are often adopted in similar form by other countries around the globe; but notwithstanding this, **regulatory approaches still differ fundamentally**.

Historically, most markets have adopted a **risk-based approach**, which considers not only the properties of a specific chemical, but also the likelihood of exposure and the level of harm that could result. Under this approach, many PFAS and their uses are considered safe as long as exposure is controlled and appropriate risk management measures are in place. US federal regulations primarily follow this approach, covering a limited range of PFAS in specific applications.[45]

Conversely, a **hazard-based approach** considers the inherent hazardous properties of a chemical. If a chemical has certain hazardous properties (e.g., if it is considered a substance of very high concern), its use may be restricted regardless of the level of exposure or estimated risk to humans or the environment from a specific application. Based on the precautionary principle, the hazard-based approach was recently adopted by a number of US states;[xiv] and it underpins the ongoing revision of REACH and the EU Chemicals Strategy for Sustainability.

In reality, most regulatory regimes sit on a spectrum between these two approaches, blending elements of both. For example, while the EU initially adopted a risk-based approach, regulating specific PFAS in a limited number of use cases, it has since increased the number of substances covered and expanded regulation to multiple non-essential applications such as food delivery packaging (see Box C). With the new PPWR and the introduction of a 'universal PFAS restriction' under REACH, the EU is moving towards a hazard-based approach.

The extent to which regulators prioritise a risk-based or hazard-based approach in different contexts is reflected in how PFAS are categorised, which applications are regulated and which contamination thresholds are deemed acceptable. The resulting lack of harmonisation makes it difficult for businesses to navigate the global regulatory landscape.

[xi] Even within markets, regulations are not always fully harmonised due to their historical development.

[xii] The OECD lists approximately 4,730 PFAS in its comprehensive database. The EU, following the OECD definition of PFAS, however, recognises over 10,000 PFAS in its regulatory scope, including substances with the potential to degrade into persistent PFAS.

[xiii] China is a signatory to the Stockholm Convention and has started to regulate additional PFAS substances that go beyond those restricted by the convention. While China's PFAS regulation is still less stringent than the EU's and enforcement remains inconsistent, potential further restrictions are planned.

[xiv] California, Colorado, Connecticut, Hawaii, Maine, Maryland, Minnesota, New York, Rhode Island, Vermont and Washington.

The global regulatory landscape for PFAS remains highly fragmented making it difficult for businesses to navigate

Box D: Intentionality and measurement

There is some debate as to whether regulation should prohibit all PFAS[xv] in food packaging or should target only intentionally added PFAS. While approaches differ, all are executed through the same mechanism: the imposition of maximum allowable PFAS thresholds. These thresholds aim to ensure that an end product is safe for consumer use and will not cause harm to the environment. They differ substantially between markets, depending on whether specific PFAS levels are viewed as intentional additions or as unintended background contamination from production or recycled content.[xvi] These divergences also reflect the fact that different regulators regard different levels as 'safe' for consumers and the environment.

To facilitate regulatory compliance, regulators provide guidance on PFAS testing, including on measurement methodologies, reporting requirements and testing responsibilities.

Multiple test methodologies are used, which vary in sensitivity and duration, among other things. Regulators should ensure that methodologies are harmonised within their market and support harmonisation across markets to ensure that measurement results are comparable. Responsibility for PFAS testing and documentation may lie with suppliers of packaging components (e.g., substrates, coatings, adhesives), packaging producers and/or importers. Different players in the value chain, including brand owners, may have to furnish regulators with evidence of their own or suppliers' PFAS tests and adherence to set thresholds – as is mandatory, for example, in Australia[32] and Denmark,[33] and as is included in the proposal for the new PPWR. Regulators may wish to monitor PFAS levels in relevant product categories and conduct regular inspections to ensure communities are protected from PFAS risks, as already happens in countries such as Denmark.[34]

[xv] 'Intentionally added substances' are generally understood as intentionally added raw materials and substances (e.g., during the production of a material or product). The term 'non-intentionally added substances' encompasses impurities in substances, reaction intermediates formed during the production process or decomposition, reaction products and contamination (e.g., via recycling). The terms were originally introduced by the EU Commission Regulation (EU) No 10/2011 in the context of plastics food contact materials, and since got established across applications in scientific publications and beyond.

[xvi] For example, the Danish guided indicator value of 20 parts per million of dry weight total organic fluorine was established as a means of differentiating between intentionally added PFAS and background levels of PFAS in paper/cardboard food contact materials.

Figure 3

Exemplary PFAS thresholds of different markets

Market	Regulation	Maximum allowable PFAS limit
Denmark	Order No. 681	• **20 parts per million (ppm)** of total organic fluorine in paper- and board-based as well as cellulose-based food packaging
EU	Packaging and Packaging Waste Regulation (PPWR)* (latest proposal)	• **25 parts per billion (ppb)** for any non-polymeric PFAS in food packaging as measured with targeted PFAS analysis • **250 ppb** for the sum of non-polymeric PFAS measured as sum of targeted PFAS analysis, optionally with prior degradation of precursors • **50 ppm** for PFAS (polymeric PFAS substances included)
California	Assembly Bill 1200	• **100 ppm** of total organic fluorine in food packaging

*Limits come from the proposal for the amendment of REACH into a universal PFAS restriction, and hence have not been established specifically for food contact materials

2.2 Potential pathways for future regulation

The regulatory direction of travel is clear: stricter PFAS regulations are increasingly being adopted and non-essential applications such as food delivery packaging are key targets. While the markets leading the transition to a hazard-based approach are generally introducing more sweeping restrictions, regulations are also being tightened in several markets that follow a traditional risk-based approach. Looking ahead, two potential outcomes seem probable.

First, the **partial phaseout of specific PFAS in food packaging** may be quicker and easier for industries to implement in the short term, affording more options for substitution. Incremental bans allow companies – especially packaging manufacturers – to make adjustments with fewer disruptions to their operations. However, partial bans also risk perpetuating the issue of regrettable substitutions (see Box E), where banned chemicals are replaced by structurally and functionally similar alternatives that pose comparable environmental and health risks. Additionally, partial bans can create long-term uncertainty for businesses, as future regulations may be needed to address the safety concerns of these substitute chemicals, leading to continuous adjustments and market disruption.

In contrast, the **full phaseout of non-essential uses of PFAS, such as food delivery packaging**, would dramatically reduce the risk of regrettable substitutions; provide stronger, more comprehensive consumer protection from PFAS exposure; and potentially increase the circularity of food delivery packaging – for example, by improving the quality of recycling outputs or facilitating the scale-up of reuse solutions. Full bans, implemented through strict thresholds (see Box D and Chapter 4.1), prohibit the use of all PFAS in a specific use case.[xvii] They address the persistent and bioaccumulative properties of the entire PFAS class, facilitating timely regulatory action without the need for lengthy assessments of individual chemicals. This approach arguably offers greater clarity and stability for companies, as it eliminates the threat of incremental regulatory expansion. Such a strong regulatory signal should also promote the development of more sustainable and innovative alternatives, including reduction of unnecessary packaging or uses of PFAS, reuse and natural substitutes. However, there is a risk that businesses may shift towards non-PFAS alternatives (e.g., polyethylene coatings) that impede other sustainability objectives, such as recycling. Full phaseouts have also been criticised as excessive by industry – in particular, by producers of fluoropolymers, because of their perceived lower impacts, their industrial importance and the economic repercussions of a total ban. However, multiple international food packaging players – including several major fast-food chains[xviii] – have pledged to remove PFAS from consumer-facing packaging.[35]

[xvii] See Box D for details of how full PFAS bans are enforced in different markets. The exact scope of a ban will also depend on the PFAS definition followed in a market.

[xviii] Among others, Wendy's committed to eliminate PFAS from all consumer packaging in the US and Canada by the end of 2021; Starbucks committed to eliminate PFAS from its food packaging materials in the US by the end of 2022 and internationally by the end of 2023and McDonald's and Burger King announced a commitment to eliminate PFAS from all food packaging globally by 2025.

Box E: Regrettable substitutions

Regrettable substitutions can be an unintended outcome of the regulation of individual PFAS. The term refers to the replacement of a substance of concern with an alternative that is subsequently found to have similar or worse health or environmental impacts. In the case of PFAS, regulations such as the Stockholm Convention phased out the use of long-chain PFAS due to mounting evidence of their harmful effects, leading manufacturers to substitute these chemicals with shorter-chain PFAS. As illustrated in Figure 4, while concentrations of historically common PFOS and PFOA were becoming less prevalent in US breast milk samples from 1995 to 2020, novel PFAS were increasing.

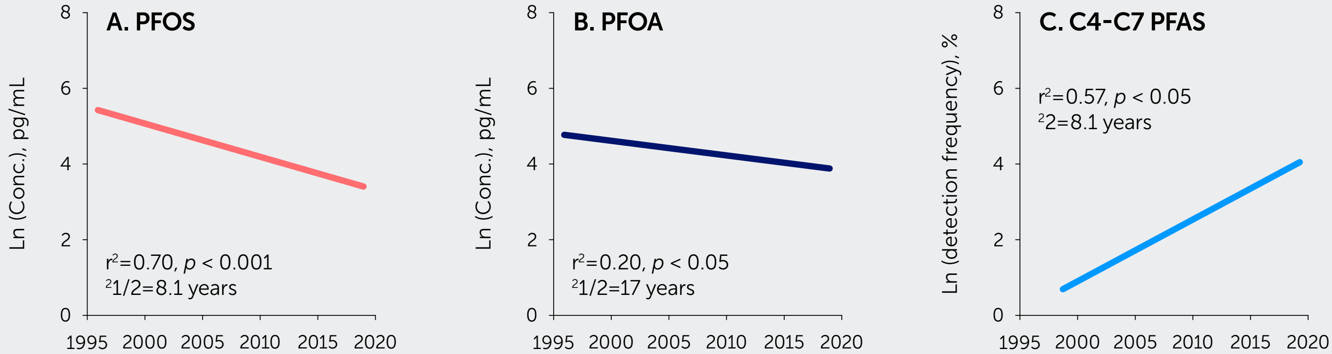
While short-chain PFAS were initially considered safer, the latest evidence suggests that they are more mobile, have similar health risks and have become ubiquitous in the environment. This illustrates the pitfalls of focusing on specific chemicals rather than adopting a more comprehensive precautionary approach.

While this can relate to the phaseout of chemicals of concern, the same concept applies more generally to switches to packaging formats that have undesirable environmental or health impacts (e.g., are less recyclable or have a higher CO_2 footprint; see Chapter 4.1 for more details).

Figure 4

Regrettable substitution: decline of regulated PFAS, rise of shorter-chain alternatives

PFAS levels in breast milk samples in the US from 1995-2020 illustrate that levels of PFAS covered in early regulations are declining (PFOS and PFOA) while in parallel levels of substitute PFAS are increasing (C4-C7 PFAS). Adapted from Zheng et al (2021).[36]



2.3 The case for a full phaseout of PFAS from food delivery packaging

There is a strong case for a full phaseout of PFAS from food delivery packaging:

- **Evidence is growing of the negative impacts of PFAS, particularly in food contact materials:** Scientific knowledge and policymakers' awareness of the risks of PFAS in general, and their use in food contact materials specifically,[37] continue to develop, increasing regulatory pressure on PFAS use in food delivery packaging.
- **Partial bans have led to regrettable substitutions:** Across markets, the restriction of a limited number of PFAS has led to their substitution with structurally similar, unregulated PFAS that were subsequently found to be equally hazardous (see Box E). This is now driving regulation of a wider range of PFAS.
- **Regulation is increasingly focused on avoiding non-essential uses:** Given that food delivery packaging is not necessary for health or safety or critical for the functioning of society, more stringent regulation of the use of PFAS in this application is likely.
- **PFAS-free alternative food delivery packaging is available at reasonable cost and comparable performance:** Acceptable alternatives that do not lead to regrettable substitution of PFAS already exist (see Chapter 3).

In light of these trends, businesses should proactively transition to PFAS-free alternatives for food delivery packaging. Taking voluntary action can help to mitigate regulatory, operational and reputational risks. Given the acceleration of regulation in recent years, it is anticipated that a growing number of markets will extend restrictions to food delivery packaging, potentially on short timelines, causing unpredictable shocks. Pre-empting these will enable businesses to control the pace of transition and thus the costs of disruption, allowing for careful substitution with safe, sustainable, competitive alternatives.

By transitioning away from PFAS, firms also avoid the reputational and legal risks associated with the use of similarly harmful materials. Proactive firms can thoroughly evaluate and implement sustainable alternatives, avoiding unintended consequences such as higher greenhouse gas emissions or end-of-life environmental impacts. Numerous players in the food packaging industry – including chemicals and packaging producers,[38] fast-food chains[39] and retailers[40] – have already voluntarily committed to phasing out PFAS from their products, increasing the pressure for regulators to follow.

But while **proactive corporate action is both desirable and feasible, it is by no means easy.** The next chapter examines the practicalities of phasing out PFAS from food delivery packaging and the challenges that players along the value chain face. Finally, Chapter 4 outlines how players can collaborate, and how policymakers can put in place enabling policies, to facilitate the transition to safe and sustainable alternatives.

PFAS-free alternatives and their adoption

3.1 Evaluating the need for PFAS-free alternatives

Before considering alternatives, businesses should assess whether reusable or redesigned packaging could eliminate the need for PFAS. Figure 6 sets out a framework for navigating these options by following the waste hierarchy.

First, consider the **feasibility of reusable PFAS-free alternatives** as a substitute for single-use food delivery packaging. Examples of PFAS-free reusable packaging include stainless steel containers, glass containers with silicone lids, or PFAS-free reusable plastic packaging. Reusable packaging, while still niche in most markets, is gaining traction. For example, under the PPWR, distributors of takeaway food and beverages in the EU should offer 10% of products in a reusable packaging format from 2030.[41] More ambitious countries and regions may move faster or go further. For example, Germany began mandating reusable packaging for food and drinks in 2023, with platforms such as Vytal partnering with over 6,500 restaurants to offer polypropylene products. However, there are significant challenges to the widespread adoption of reusable alternatives in food delivery packaging, including behaviour change among consumers and restaurants. If these solutions do not achieve a high number of effective use cycles, they may lead to worse sustainability outcomes.[xix] Without supportive policies and industry-wide collaboration, individual businesses will struggle to scale reuse. In such cases, they should consider long-term action to advance the reuse system and evaluate alternative PFAS-free solutions.

If single-use food delivery packaging is deemed necessary, a **packaging redesign** should be considered. Some applications may not require a barrier coating or additive if the functional requirements have been over-specified.

For instance, packaging manufacturers and sourcers that participated in the research for this report recounted that some packaging formats (e.g., paperboard lids) work without PFAS and grease resistance is often of aesthetic value rather than being strictly necessary. In such cases, businesses could eliminate the use of PFAS without adopting an alternative.

Substitution with alternatives is the next option. This could involve replacing either the packaging material (substrate) with something that does not require PFAS or the PFAS additive with an alternative.

All of these decisions require careful consideration of economic factors (e.g., cost, scalability) **and broader system factors** (e.g., health impacts, end-of-life implications and broader sustainability priorities). These are covered in more detail in Chapter 3.3. Where PFAS functionality is required but no sustainable and viable alternatives exist, **targeted innovation** may be required. This can include collaboration across industry and with the public sector to advance more sustainable business models, materials or additives. For instance, industry players can collaborate with municipalities to trial and scale reuse models; or can research, evaluate and scale sustainable alternatives using locally available materials (see Chapter 4).

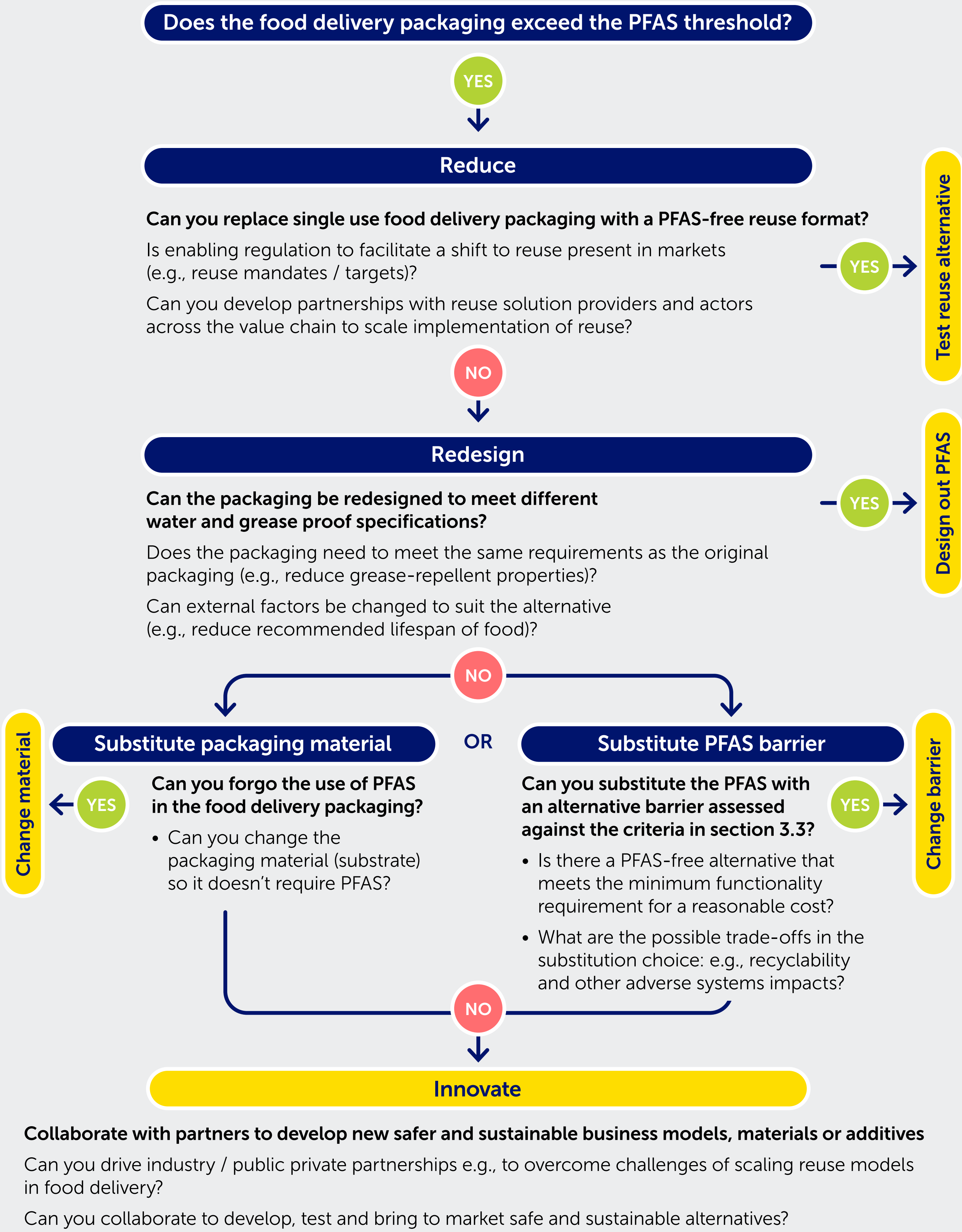
The following sections provide context on PFAS-free alternatives for food delivery packaging[xx], and outline the challenges associated with their adoption, before Chapter 4 explores the resulting implications for businesses and policymakers.

[xix] For a deeper look at the challenges, potential and required action on reuse more generally, see the Ellen MacArthur Foundation study Unlocking a Reuse Revolution: Scaling Returnable Packaging.

[xx] These recommendations are specifically tailored to food delivery packaging, a subset of the broader food packaging category. While many of the insights and requirements may be applicable to food packaging in general, this report does not cover all regulatory or practical considerations.

Figure 5

Decision tree framework for substituting PFAS in food delivery packaging



3.2 PFAS-free alternatives

Many PFAS-free alternatives for food delivery packaging are already available that meet the necessary functionality requirements. The Nordic Council of Ministers defines this as the 'ability to repel fat and water over time and at high temperatures'.

In each case, the optimal PFAS alternative will depend on factors such as application, packaging format, local regulatory context and local waste management infrastructure. Examples of substitutes include the following:

- **Barriers:**
  - **Coatings:** Physical barriers (e.g., bioplastic, such as polylactic acid (PLA); aluminium or polyethelyne) and chemical barriers (e.g., wax and oil-based coatings, such as beeswax, vegetable wax or paraffin wax).
  - **Additives to packaging material (substrate):** It may be possible to substitute the substrate with something that does not require additives (e.g., natural uncoated fibres such as untreated paperboard, bagasse or algae; bioplastics such as PLA; and traditional materials such as plastics or metals).
- **Processing aids:** Silicone-based and vegetable-based lubricants.

Box F: Defining 'PFAS-free'

Packaging materials that contain PFAS levels below regulatory thresholds deemed safe can be labelled 'PFAS free'. These thresholds, which differ across regulatory regimes, typically align with 'non-intentionally added' levels of PFAS and are often expressed as health-based guidance values.

3.3 Challenges associated with the adoption of PFAS-free alternatives

While alternatives to PFAS in food delivery packaging exist, there are significant challenges to their adoption, in terms of identifying where substitution is necessary, selecting suitable alternatives and implementing the change. These steps and the associated obstacles are illustrated in Figure 6 and described in detail below.

Figure 6

Overview of challenges for value chain players in transitioning to PFAS-free alternatives

Chemical production | Packaging manufacturer | Packaging sourcing | Food delivery platform | Restaurants

Magnitude of challenge experienced

High | Mid | Low

Value chain mapping

Challenges and underlying obstacles	Chemical production	Packaging manufacturer	Packaging sourcing	Food delivery platform	Restaurants
Step 1: Identification of where and why substitution is required					
Lack of supply chain transparency					
Confidentiality (IP) concerns	High	High			
Lack of standardised definition of PFAS and its threshold	High	High	High	High	High
Lack of information provided by suppliers		Mid	High	High	High
Lack of standardised PFAS testing methodology		Mid	Low	Low	Low
Limited PFAS awareness					
Limited PFAS awareness	Mid	Mid	Mid	Mid	Mid
Limited education			Mid	Low	High
Corporate silos		Mid			
Step 2: Selection of PFAS-free alternatives					
Trade-offs with system impacts					
Trade-offs with system impacts*			High	High	High
Commercial trade offs**		Mid		Low	High
3. Implementation of the switch to PFAS-free packaging					
Unclear policy direction					
Uncertain timeline	High	High	Low	Low	Mid
Fragmented regulation	High	High	Low	Low	High
Limited demand for PFAS-free					
Price sensitivity					Mid
Supply chain and operational adjustments					
Process modifications		High			
Supplier modification needed		Mid	Mid		Mid

*End of life, carbon footprint, land use priorities.

*Potential cost increases, limited scalability, poorer functionality

Challenge 1: Identifying where and why substitution is required

Businesses face challenges managing PFAS due to **limited understanding** and, in larger corporations, fragmented expertise across organisations. Smaller restaurants often lack awareness of PFAS and alternatives, complicating decision-making. Larger firms may have PFAS expertise, but it can be **siloed** (e.g., in R&D or sustainability teams) and can get lost among competing priorities in companies not focused on chemicals. However, as regulations emerge in key markets, PFAS can quickly become a board-level issue.

Lack of supply chain transparency makes it difficult to assess PFAS exposure and determine where substitutions are needed. Packaging producers and their suppliers often lack knowledge of the chemicals in their products, as upstream players treat this information as **confidential**. While targeted tests are available for the most common PFAS, each is limited to just one of the thousands of commercially available PFAS. Methods for non-targeted screening measure the content of organic fluor – a useful proxy for PFAS content. However, such methods can be time and resource intensive and may thus be unsuitable for routine screening.

The absence of standardised definitions, detection thresholds, and testing methods (discussed in Chapters 1 and 2) complicates regulatory compliance. These ambiguities discourage companies from claiming their products are 'PFAS free' due to potential legal risks and accusations of misleading claims, as shown by the class action against a company that marketed its cookware as PFAS-free, despite containing fluoropolymers.[xxi]

Challenge 2: Selecting PFAS-free alternatives

Choosing an alternative involves navigating a complex set of trade-offs and in each case the optimal alternative will be highly context dependent (as outlined in Chapter 3.2).

PFAS-free alternatives must meet minimum functionality and cost-competitiveness requirements, which are achievable in many applications today.[42] Stakeholders that have phased out PFAS emphasise the importance of setting **functionality requirements** to compare PFAS-free alternatives.

Restaurants and packaging producers report at most a 5%-10% increase in **packaging costs** when switching to PFAS-free materials in fibre-based packaging. While this represents a small fraction of the end product price for consumers, restaurants often operate on low margins and strive to minimise costs. The main financial burden falls on packaging manufacturers, which face significant process adaptation costs, including potential capital investments and higher operational expenses (covered in Challenge 3).

There is no single silver bullet and each alternative requires careful consideration of trade-offs, ensuring that the PFAS-free alternative does not pose similar health or environmental hazards. Beyond commercial priorities of functionality, scalability and cost, considerations should include **toxicity; end-of-life impacts** such as recyclability; **resource consumption** and **carbon footprint**. Without proper evaluation, there is a risk of **regrettable substitutions**, where the alternative introduces new hazards that counter the benefits of eliminating PFAS.

[xxi] Fluoropolymers are considered PFAS under the OECD (2021) definition of PFAS but not under certain others (e.g., the definition adopted by the US Environmental Protection Agency).

Box G:
Example of trade-offs in alternative selection

Figure 7 illustrates the trade-offs between four common alternatives to PFAS barriers used in paper and plant-fibre packaging. Polyethylene laminated coatings are functional and cheap but are carbon intensive and present recycling challenges. Beeswax coatings are biodegradable and non-toxic, although they come with higher costs and less grease resistance, and supply limits scalability. Paraffin wax coatings are cost-effective and functional but raise environmental concerns due to their fossil fuel origins. Seaweed-based packaging provides a biodegradable, non-toxic alternative with a low carbon footprint and minimal land use; while it is not yet scaled, it is inherently scalable due to seaweed availability. PFAS coatings widely used today come with significant trade offs because of their toxicity and contamination of recycling and composting recovery streams.

Evaluation of these trade-offs requires value judgements that are specific for different players as well as their regional and regulatory contexts. For instance, premium brands positioned as sustainable may prioritise PFAS-free alternatives with low carbon footprint, even if they are more expensive. Meanwhile, mass market operations may focus on cost-effective solutions like polyethylene coatings, even if they pose recycling challenges, as price and scalability take precedence.

Figure 7

Trade-offs between PFAS-free alternatives on key criteria

Comparison of PFAS-free barriers

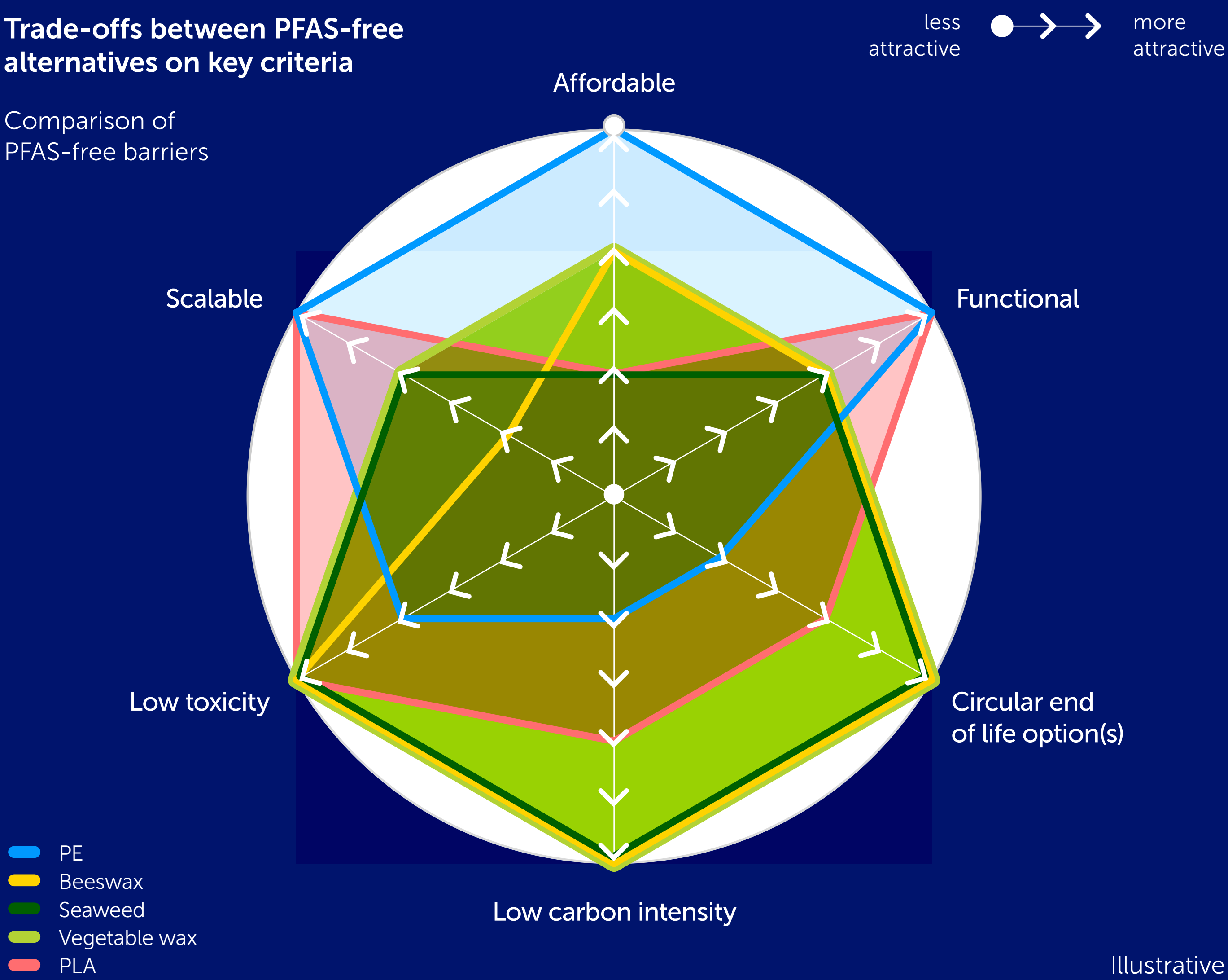


image: www.notpla.com

Challenge 3: Implementing the switch to PFAS-free packaging

Tight transition timelines can prove challenging for reactive industry players. For example, one packaging player reported that some US states required the phaseout of non-polymeric PFAS in food packaging in less than 12 months, forcing them to deploy and test alternative solutions at scale, rather than conduct traditional pilot testing. **Divergences** in how PFAS are defined, in terms of both chemical structure and permissible thresholds, are also difficult for global companies to navigate; while for US players, fragmentation at the state level may in practice mean implementing the most stringent restrictions..

Limited demand for PFAS-free alternatives increases the pressure on early adopters, especially when downstream partners are unaware of the problem (see Chapter 1) or resistant to changes in cost, aesthetics or functionality. Some customers may be deterred by unfamiliar product specifications or labelling.

The transition also requires **operational changes**, particularly for upstream players, including modifying production processes and retraining staff. For example, one plastic packaging firm experienced a temporary decline in efficiency in its first year of implementing a new PFAS-free coating. Additionally, **supply chain adjustments** may be necessary; whereas larger companies can leverage their buying power to facilitate supplier cooperation, smaller firms may need to switch suppliers entirely.

In summary

The shift to PFAS-free solutions is achievable, but businesses face complex challenges of regulatory uncertainty, supply chain adjustments and operational shifts – all of which require coordinated efforts. But while downstream players demand improved labelling and transparency, upstream manufacturers will be reluctant to make changes without strong market demand. This dynamic can stall progress, requiring clear policies, harmonised regulation and synchronised action across the value chain to unlock the transformation. The next chapter proposes pathways for businesses to overcome these barriers and for policymakers to create the enabling conditions needed for a smooth transition.

Chapter 4

A roadmap to PFAS-free food delivery packaging

Phasing PFAS out of food delivery packaging requires coordinated action from both policymakers and businesses.

As outlined in Chapter 3, by proactively phasing out PFAS, businesses can mitigate regulatory, operational and reputational risks while retaining control over the pace of transition. In doing so, they must overcome challenges related to identifying where substitution is required, selecting safer alternatives to PFAS and implementing these solutions effectively.

While businesses can be proactive, policymakers are key: they can catalyse the pace and scale of action by providing certainty on the future of PFAS in food delivery packaging and required action by adopting a clear strategic direction, defining coherent objectives, timelines and standards, as well as providing targeted support for sustainable solutions.

This chapter examines how policymakers can provide greater certainty, before outlining the levers available to business.

4.1 Levers for policymakers

Policymakers have a crucial role to play in the transition to PFAS-free food delivery packaging – not only by providing a clear direction of travel and hence clarifying where substitution is required, but also by defining the framework for safe and sustainable alternatives. They can also facilitate the switch to PFAS-free alternatives by providing targeted support for the scale-up of safe and sustainable solutions.

Step 1:
Introduce clear regulations to phase out PFAS from food delivery packaging

Clarity is needed on where, when, by whom and to what extent PFAS will be phased out. Hence, regulations should specify maximum allowable PFAS thresholds (see Figure 3 for example ranges); set clear, achievable timelines for phaseout (see Box H); and provide guidance on transparency requirements and traceability processes, including measurement responsibilities and standardised methodologies. In doing so, and through engagement in multilateral forums, policymakers should work towards international harmonisation – for example, by adopting the widely used OECD definition of PFAS and/or aligning measurement methods and PFAS thresholds for intentional use. Ongoing UN negotiations on a legally binding instrument to end plastic pollution could also present an opportunity for harmonisation. Proposals include making PFAS 'subject to requirements to avoid and minimise their use, and … to close monitoring and reporting requirements … as part of transparency and traceability controls'.[43] As such, an international instrument could enable a more streamlined global approach to PFAS regulation.

Box H: Timelines for the transition to PFAS-free alternatives

When establishing timelines for the phaseout of PFAS, it is essential to strike a balance between ensuring timely action and allowing industry sufficient time for the transition. Brand owners may be able to accelerate the switch to PFAS-free packaging by adjusting their procurement, while being careful to avoid regrettable substitutions. Chemicals and packaging producers face more complex challenges, as changes to their formulations and production processes are required. The transition to PFAS-free packaging may be faster for producers with bigger R&D departments.

Thus far, the timelines that regulators have set for compliance with PFAS bans in food packaging vary from **10 months to several years**. For example, the Danish ban on PFAS in food contact paper and board materials allowed **10 months** for implementation;[44] the ban on PFAS in food contact materials in the EU is set to take effect **18 months** after the entry into force of the PPWR;[45] and a voluntary PFAS phaseout in food packaging initiated by the US Food and Drug Administration gave companies **three years** for implementation.[46]

Step 2: Targeted support for the scale-up of safe and sustainable PFAS-free alternatives

Robust regulation can facilitate the phaseout of PFAS in food delivery packaging, especially as alternatives are already available at competitive cost, which should further reduce with scale. However, a phaseout requirement alone may lead to regrettable substitutions with non-sustainable or unsafe alternatives. Policymakers may therefore wish to promote the development of locally scalable, safe and sustainable solutions. This can include, for example, the scaling of bagasse-based solutions in countries with a high availability of sugar cane, such as Brazil, bio-based plastics made from agricultural production residues when this is readily available, as done e.g., by the start-up traceless in Germany, or seaweed-based solutions in countries with corresponding resources, such as the UK, where start-up Notpla has developed seaweed-based materials.

This support should be strictly limited, as the phaseout regulation should already provide a strong market signal for investment in alternatives. For instance, an innovation competition may be a cost-effective way to identify promising approaches; while the development of public-private partnerships, public procurement or offtake agreements for sustainable PFAS-free alternatives as well as interest-free loans to scale their production could help to mobilise investment to achieve scale. Policy interventions are also needed to facilitate the adoption and scale-up of effective PFAS-free reuse packaging systems that can deliver both environmental and economic benefits. To this end, national policymakers may wish to set reuse targets and mandates and create financial incentives to help level the playing field between reusable and single-use options. These could include taxes on disposable packaging, tax breaks for investments in reuse solutions or direct support for municipal reuse schemes. Municipalities can pilot and promote the scale-up of reuse solutions through city-level initiatives, including by driving standardisation and the development of local infrastructure (e.g., for shared packaging collection points and cleaning).[xxii]

[xxii] The city of Aarhus and the manufacturer of reverse vending machines TOMRA have collaborated on a pilot project to scale reusable takeaway packaging locally. The initiative involves setting up automated collection points for reusable packaging, incentivised through a deposit-refund model.

Step 3:
Accelerate the transition to safe and sustainable chemicals

While the phaseout of PFAS in food delivery packaging is a vital step, many other chemicals with uncertain hazard profiles are also widely used in the industry. A coherent strategy for the systematic improvement of the safety and sustainability of chemicals should help to reduce the risk of regrettable substitutions and tackle wider issues of chemical pollution. For example, the EU Strategy for Sustainable Chemicals not only calls for the phaseout of hazardous chemicals (including PFAS), but also promotes the development of chemicals that are safe and sustainable by design; sets a zero-pollution ambition; and aligns with other environmental strategies, such as the Circular Economy Action Plan, to enable safe recycling and reuse and prevent trade-offs with other solutions.

Figure 8 summarises the key actions that policymakers should take to drive the transition to PFAS-free alternatives.

Figure 8

Policy levers

1

Clear phaseout regulations

Provide certainty to industry

- Set near term timeline for phaseout of PFAS in food delivery packaging
- Outline enforcement scheme, including clear PFAS thresholds and clarity on processes and responsibilities

Ensure transparency and traceability

- Define measurement methodologies and reporting requirements for PFAS and other chemicals used in packaging, e.g. via a product passport

Work towards international harmonisation, e.g. on:

- PFAS definition and limits
- Measurement methodologies
- Regulatory approaches and objectives for PFAS and alternatives in virgin and secondary materials

2

Support for the scale-up of safe & sustainable alternatives

Targeted support for development of sustainable alternative solutions

- R&D schemes for locally scalable, safe and sustainable PFAS-free packaging:
  - Set targeted innovation challenge missions
  - Initiate and fund R&D projects and partnerships (e.g. PPPs)
- Scale local production of safe and sustainable alternatives:
  - Offtake agreements / public procurements
  - Low interest loans

Support alternative business models (e.g., PFAS-free reuse)

- Enabling policies (e.g., reuse targets and mandates)
- Financial support (e.g., tax breaks, direct support for local schemes)
- Municipal reuse pilots

3

Accelerate transition to safe & sustainable chemicals

Clarity on measurement methodology and responsibilities for trace amounts

- Support development of standardised methodology for PFAS measurement

Reduce risk that alternative solutions are detrimental on wider sustainability

- Develop policy framework for safe and sustainable chemicals, e.g. EU's chemicals strategy for sustainability contains:
  - Phaseout of hazardous chemicals
  - Development of chemicals that are safe and sustainable-by-design
  - Zero pollution ambition
  - Alignment with other environmental strategies, e.g., to enable safe recycling and reuse

Figure 9

Levers for businesses

Chemical production | Packaging manufacturer | Packaging sourcing | Food delivery platform | Restaurants

Value chain position

Required solution	Lever	Chemical production	Packaging manufacturer	Packaging sourcing	Food delivery platform	Restaurants
Acknowledge PFAS as a priority and increase supply chain transparency	Disclose intentionally added PFAS (beyond mandatory disclosure)	✓	✓			
	Audit supply chains for PFAS and ask for extra data from suppliers		✓	✓		
	Create cross-functional task forces to assess the PFAS footprint in the product portfolio		✓			
	Include PFAS in sourcing criteria and ask suppliers for key details*			✓	✓	✓
	Test samples using third parties and compare to thresholds			✓		✓
	Form coalitions to advocate for clearer PFAS policies and thresholds	✓	✓	✓	✓	✓
Develop decision-making processes to evaluate alternatives	Create frameworks to consider PFAS-free solutions, reuse, redesign and substitutions*	✓	✓	✓	✓	
	Develop and test new materials via pilot projects with customers	✓	✓			
	Educate customers on PFAS risks and safer alternatives		✓	✓		
	Invest in R&D to innovate new substances where a safe and sustainable alternative doesn't exist	✓	✓			✓
Adapt processes and coordinate supply chain efforts	Set and communicate PFAS phase out timelines	✓	✓	✓		
	Adapt manufacturing processes that accommodate new materials		✓			
	Diversify suppliers to meet PFAS-free packaging needs*		✓	✓	✓	
	Establish procurement policies that prioritise PFAS-free packaging solutions*			✓	✓	✓
	Build communication strategies around PFAS-free packaging				✓	✓

*May be direct for the business or as part of the recommended network

Step 1:
Acknowledge PFAS as a priority and work to increase supply chain transparency

To address limited awareness and understanding of PFAS, larger businesses can establish cross-functional taskforces – ideally led by a member of senior leadership – to break down internal silos and ensure a coordinated approach to related challenges. Smaller businesses can leverage existing resources, such as ChemSec's PFAS Guide, to identify the critical issues of greatest relevance to them.

To enhance understanding of PFAS exposure in product portfolios, upstream suppliers should disclose all intentionally added PFAS in their products and monitor overall PFAS levels to identify unintentional pathways. Downstream businesses should request greater transparency from suppliers, including through joint action (e.g., via industry associations). Where information from suppliers is not forthcoming, firms can hire third-party laboratories to conduct non-targeted screening for PFAS. Suppliers can also be encouraged to collaborate by incorporating PFAS considerations into procurement processes and specifications.

Businesses can additionally establish broad coalitions and initiatives to advocate for enabling policies. Lobbying for clear and harmonised definitions of PFAS, thresholds, testing methodologies and disclosure requirements could help to address supply chain transparency issues.

Step 2:
Develop decision-making processes to phase out PFAS from the value chain

Upstream, chemical producers can phase out the production of PFAS and communicate this to customers to boost awareness and demand. In developing and testing new compounds and materials, chemical producers and packaging manufacturers can explore the PFAS-free options discussed in Chapter 3. To assess the functionality and scalability of these materials, they should deploy pilot projects and gather customer feedback from downstream players and customers. To evaluate the complex trade-offs between different options, businesses should establish decision-making frameworks (see Chapter 3.3) and testing regimes that balance cost, functionality, sustainability priorities and health and safety requirements, to ensure that the selected alternative meets both commercial and sustainability goals. These decision-making frameworks will inevitably differ between organisations due to varying value judgements regarding factors discussed in section 3.3 (e.g.. cost, functional requirements, product end-of-life ambitions.

Step 3:
Adapt processes and coordinate supply chain efforts to ensure a smooth transition to PFAS-free food delivery packaging

Upstream, businesses should modify their operational processes to accommodate substitute materials for use in coatings, packaging materials (substrates) and processing aids. They may need to invest in new equipment and training for employees to educate them about new processes. Communication will be crucial in securing buy-in across teams who might be initially resistant to process change. Downstream, businesses can establish PFAS-free procurement policies and specifications, working with suppliers that already offer PFAS-free alternatives and incentivising other suppliers to phase out PFAS from their products. Finally, businesses may want to consider how to inform their customers about the shift to PFAS-free products and food delivery packaging, linking back to Step 1.

4.3 Conclusion

As scientific understanding advances and regulatory pressure intensifies, the continued use of PFAS in food delivery packaging is becoming increasingly contentious. While a full phaseout may be challenging, it is feasible due to the availability of safe alternatives and the successful precedent set by businesses that have already eliminated PFAS from their packaging portfolios. In markets with less stringent regimes, businesses can proactively lead the transition, mitigating the risks of reacting to fragmented regulation. Acting now will enable them to stay ahead of future changes, minimise disruption and advocate for systemic shifts to scale sustainable alternatives. Policymakers play a critical role in accelerating the transition by providing regulatory clarity and targeted incentives, and advocating for global harmonisation through multilateral initiatives such as the Stockholm Convention. The most efficient and effective phase out of PFAS requires bold action from both business and policymakers.

Appendix

Overview of increasing PFAS regulation in food packaging (1/2)

		Regional/national regulations
APEC	South Korea	**1** PFAS (PFHxS and 147 related substances) included in Persistent Organic Pollutants Control Act, effectively banning or restricting them in food packaging since 2023
APEC	Australia	**2** Action Plan to Phase Out PFAS in Fibre-Based Food Contact Packaging published in 2022 that outlines a national, voluntary and industry-led approach to phasing out PFAS in fibre-based food contact packaging by 31 December 2023
EUROPE	EU	**3** Max. migration limit of 0.05 mg/kg of food simulant for PFAS used as monomers (e.g. tetrafluoroethylene or perfluoromethyl perfluorovinyl ether) in plastic food contact applications, regulated via Food Contact Plastics Regulation; since 2011 **4** REACH regulation restricts the use of certain PFAS, such as PFOA and its related substances in food packaging since 2017; increased PFOS restrictions & reporting requirements in 2021 **5** Commission recommendation to Member States to test PFAS presence in food (PFOS, PFOA, PFNA, PFHxS, PFBA and PFBS and others), since 2019 **6** Food packaging containing PFAS classified as Substances of Very High Concern (e.g. PFOA, PFOS, and PFHxS) in concentrations >0.1% must be reported to the European Chemicals Agency (ECHA) since 2021 **7** European Parliament adopted position in 11/2023 to ban PFAS in food packaging under PPWR **8** European Commission restricts use of PFHxA in food packaging in 09/2024, taking effect in 2026
EUROPE	Denmark	**9** Prohibits all PFAS in cardboard and paper food contact materials since July 2020 – recycled paper and cardboard must be separated from food with a functional barrier to prevent PFAS compounds from migrating One of the initiators of the European Chemicals Agency (ECHA) proposal to ban and/or impose strict limits on the manufacture, use, and marketing of PFAS in all products, including food packaging which is expected to come into effect around 2025
EUROPE	France	**10** Implementing national bans on PFAS in food packaging until 2025, going beyond EU regulations via the Anti-Waste Law for a Circular Economy (AGEC)
EUROPE	Netherlands	**11** Prohibit the use of PFOA, PFOS, PFNA und PFHxS in food contact materials since 07/2024

*With exception of the self-governing region Tokelau

Overview of increasing PFAS regulation in food packaging (2/2)

		Regional/national regulations
NORTH AMERICA	Canada	**12** Ban on the manufacture, use, sale, offer for sale, and import of PFOS in food packaging materials since 2008, regulated via the Prohibition of Certain Toxic Substances Regulations under the Environmental Protection Act (CEPA); CEPA also requires reporting for industries using PFAS to ensure no PFAS are present in food contact materials unless specific safety criteria are met **13** PFOA added to the above in 2016 The Canadian government is considering expanding its list of regulated PFAS in food packaging
	US – federal level	**14** Long-chain PFAS (such as PFOA and PFOS) phased out in food contact applications under the Food, Drug, and Cosmetic Act (FDCA) since 2016. Certain short-chain PFAS with ≤6 carbon atoms still allowed but under review **15** In 2021, the FDA requested the voluntary phase out of certain short-chain PFAS used in food packaging
	California	**16** Assembly Bill 1200 ('Toxic-Free Food Packaging Act') prohibits the manufacture, sale, or distribution of food packaging containing intentionally added PFAS in concentrations >100 ppm in California since 01/2023. Applies to wide range of materials, including wrappers, liners, bowls, plates, and food trays
	Vermont	**17** Ban on the manufacture, sale, and distribution of food packaging containing intentionally added PFAS in any amount since 07/2023
	Washington (state)	**18** Tiered ban on the manufacture, sale, and distribution of food packaging containing intentionally added PFAS in any amount until safer alternatives have been identified: 02/2023: wraps, plates, food boats, or pizza boxes; 05/2024: flexible bags and sleeves, bowls, flat service ware (e.g. trays and plates), open-top and closed containers
	Colorado	**19** Phase out of sale and distribution of food packaging containing intentionally added PFAS in Colorado until 2027, started in 01/2024
	Connecticut	**20** Ban of food packaging containing intentionally added PFAS introduced during manufacturing or distribution since 12/2023
	Hawaii	**21** Ban on the manufacture, sale, and distribution of wrappers, liners, plates, food boats, and pizza boxes containing intentionally added PFAS in any amount since 01/2024
	Maine	**22** Ban on the manufacture, sale, and distribution of food packaging containing intentionally added PFAS in any amount above incidental presence since 01/2024
	Maryland	**23** Ban on the manufacture, sale, and distribution of food packaging containing intentionally added PFAS since 01/2024
	Minnesota	**24** Ban on the manufacture, sale, and distribution of food packaging containing intentionally added PFAS since 01/2024, providing for a range of civil and criminal penalties, and injunctive relief
	Rhode Island	**25** Ban on food packaging containing intentionally added PFAS in production or manufacturing since 01/2024
	New York (state)	**26** Ban on distribution and sale of food packaging containing intentionally added PFAS since 12/2022
UN	Stockholm signatories	**27** The Stockholm Convention bans the use of PFOS (since 2009), PFOA, and PFHxS (both since 2019), and their derivatives in food contact materials, including packaging

*With exception of the self-governing region Tokelau

References

[1] Russell, M.H. et al. (2008) 'Investigation of the biodegradation potential of a fluoroacrylate polymer product in aerobic soils', *Environmental Science & Technology,* 42(3), pp.800-807.

[2] Gomis, M.I., et al. (2018) 'Comparing the toxic potency in vivo of long-chain perfluoroalkyl acids and fluorinated alternatives', *Environment International,* 113, pp.1-9.

[3] Environmental Working Group (EWG) (2024) *PFAS in wildlife.* Available at: https://www.ewg.org/interactive-maps/pfas_in_wildlife/map/ (Accessed: 24 September 2024).

[4] Filgo, A.J. et al. (2013) 'PFAS in wildlife tissues', *Environment International,* 55, pp.100-105.

[5] Zheng, G. et al. (2021) 'Per- and polyfluoroalkyl substances (PFAS) in breast milk: Concerning trends for current-use PFAS', *Environmental Science & Technology,* 55(11), pp. 7510-7520.

[6] Buck, R.C. et al. (2011) 'Perfluoroalkyl and polyfluoroalkyl substances in the environment: terminology, classification, and origins', *Integrated Environmental Assessment and Management,* 7, pp.513-541.

[7] Hammel, E. et al. (2022) 'Implications of PFAS definitions using fluorinated pharmaceuticals', *iScience*, 25(4), p.104020.

[8] Organisation for Economic Co-operation and Development (OECD) (2021) *Reconciling terminology of the universe of per- and polyfluoroalkyl substances: Recommendations and practical guidance,* OECD Publishing, Paris.Available at: https://www.oecd-ilibrary.org/environment/reconciling-terminology-of-the-universe-of-perand-polyfluoroalkyl-substances_e458e796-en (Accessed 15 August 2024).

[9] Glüge, J. et al. (2020) 'An overview of the uses of per- and polyfluoroalkyl substances (PFAS)', *Environmental Science: Processes & Impacts,* 22(12), pp. 2345-2373.

[10] IMARC Group (2020) *Online food delivery packaging market.* Available at: https://www.imarcgroup.com/online-food-delivery-packaging-market (Accessed: 24 September 2024).

[11] Strakova, J. et al. (2020) *PFAS in food contact materials: A European study.* Available at: https://www.envhealth.org/wp-content/uploads/2021/05/FINAL_pfas_fcm_study_web.pdf (Accessed: 24 September 2024).

[12] Australian Packaging Covenant Organisation (APCO) (2021) *PFAS in fibre-based packaging.* Available at: https://documents.packagingcovenant.org.au/public-documents/PFAS%20in%20Fibre-Based%20Packaging (Accessed: 24 September 2024).

[13] Shine Lawyers (2024) *Jervis PFAS compensation case.* Available at: https://shine.com.au (Accessed: 9 September 2024).

[14] Zabaleta, I. et al. (2020) 'Occurrence of per- and polyfluorinated compounds in packaging materials', *Food Chemistry,* 321, p.126746.

[15] Begley, T.H. et al. (2008) 'Migration of fluorochemical paper additives from food-contact paper into foods', *Food Additives & Contaminants: Part A*, 25, pp.384-390.

[16] Choi, Y.J. et al. (2019) 'Perfluoroalkyl acid characterization in U.S. municipal organic solid waste composts', *Environmental Science & Technology Letters,* 6(6), pp.372-377.

[17] United States Environmental Protection Agency (EPA) (2024) *Our current understanding of the human health and environmental risks of PFAS.* Available at: https://www.epa.gov/pfas/our-current-understandinghuman-health-and-environmental-risks-pfas (Accessed: 24 September 2024).

[18] C8 Medical Monitoring Program (2024) *C8 medical monitoring program.* Available at: http://www.c-8medicalmonitoringprogram.com (Accessed: 24 September 2024).

[19] Grandjean, P. et al. (2012) 'Serum vaccine antibody concentrations in children exposed to perfluorinated compounds', *JAMA,* 307(4), pp.391-397.

[20] Kim, M.J. et al. (2018) 'Association between perfluoroalkyl substances exposure and thyroid function in adults: A meta-analysis', *PloS One*, 13(5), p.e0197244.

[21] Maxwell, D.L. et al. (2024) 'Mixtures of per- and polyfluoroalkyl substances (PFAS) alter sperm methylation and long-term reprogramming of offspring liver and fat transcriptome', *Environment International,* 186, p.108577.

[22] Ehrlich, V. et al. (2023) 'Consideration of pathways for immunotoxicity of per- and polyfluoroalkyl substances (PFAS)', *Environmental Health*, 22 (1), p. 19.

[23] EFSA Panel on Contaminants in the Food Chain (CONTAM) (2018) 'Risk to human health related to the presence of perfluorooctane sulfonic acid and perfluorooctanoic acid in food', *EFSA Journal*, 16(12), p.5194.

[24] Messmer, M.F et al. (2022) 'Risk of cancer in a community exposed to per- and poly-fluoroalkyl substances', *Environmental Health Insights*, 16, p.11786302221076707.

[25] Hall, S.M. et al. (2022) 'Concentrations of per- and polyfluoroalkyl substances (PFAS) in human placental tissues and associations with birth outcomes', *Chemosphere*, 295, p.133873.

[26] Liu, Z. et al. (2023) 'Associations of gestational perfluoroalkyl substances exposure with early childhood BMI z-scores and risk of overweight/obesity: Results from the ECHO Cohorts', *Environmental Health Perspectives,* 131 (3).

[27] Burdeau, D. et al. (2024) 'Early pregnancy plasma per- and polyfluoroalkyl substances (PFAS) and maternal midlife adiposity', *Journal of Clinical Endocrinology & Metabolism*. Available at: https://academic.oup.com/jcem/advance-article-abstract/doi/10.1210/clinem/dgae542/7745629 (Accessed: 24 September 2024).

[28] Ankley, G.T. et al. (2020) 'Assessing the ecological risks of per- and polyfluoroalkyl substances: Current state-of-the-science and a proposed path forward', *Environmental Toxicology and Chemistry,* 40 (3), pp. 564-605.

[29] Parker, E.D. et al. (2024) 'Economic costs of diabetes in the U.S. in 2022', *Diabetes Care*, 47(1), pp. 26-43.

[30] Goldenman, G. et al..(2019) Cost of inaction: *A socio-economic analysis of environmental and health impacts linked to exposure to PFAS.* Nordic Council of Ministers, Copenhagen. Available at: http://norden.diva-portal.org/smash/record.jsf?pid=diva2%3A1295959&dswid=6315 (Accessed: 24 September 2024).

[31] Alston & Bird LLP (2024) *PFAS litigation tracker.* Available at: https://alstonpfas.com/category/litigation/ (Accessed: 24 September 2024).

[32] Australian Packaging Covenant Organisation (2023) *Action plan to phase out PFAS in fibre-based food contact packaging.* Available at: https://documents.packagingcovenant.org.au/publicdocuments/Action%20Plan%20to%20Phase%20Out%20PFAS%20in%20Fibre-Based%20Food%20Contact%20Packaging (Accessed: 16 September 2024).

[33] Future Policy (2024) *Danish order on food contact materials.* Available at: https://www.futurepolicy.org/global/danish-order-on-food-contact-materials/ (Accessed: 12 September 2024).

References

[34] Chemycal (2024) *Denmark to advance understanding of PFAS risks with eight new projects in 2024*. Available at: https://chemycal.com/news/e75b2265-d0ed-40fa-a7b0-80a3d834405f/Denmark_to_Advance_Understanding_of_PFAS_Risks_with_Eight_New_Projects_in_2024 (Accessed: 20 September 2024).

[35] Toxic-Free Future (2024) *Retailers committing to phase out PFAS as a class in food packaging and products*. Available at: https://toxicfreefuture.org/mind-the-store/retailers-committing-to-phase-out-pfas-as-a-class-infood-packaging-and-products/#fast-food (Accessed: 19 September 2024).

[36] Zheng, G. et al. (2021) 'Per- and polyfluoroalkyl substances (PFAS) in breast milk: Concerning trends for current-use PFAS', *Environmental Science & Technology,* 55(11), pp. 7510-7520.

[37] Phelps et al. (2024) 'Per- and polyfluoroalkyl substances in food packaging: Migration, toxicity, and management strategies', *Environmental Science & Technology,* 58(13), pp. 5670-5684.

[38] Food Packaging Forum (2020) *6:2 FTOH manufacturers to phase out use in food packaging*. Available at: https://www.foodpackagingforum.org/news/62-ftoh-manufacturers-to-phase-out-use-in-food-packaging (Accessed: 19 September 2024).

[39] TastingTable (2022) *Fast food brands promise change to packaging after startling report.* Available at: https://www.tastingtable.com/811333/fast-food-brands-promise-change-to-packaging-after-startling-report/ (Accessed: 19 September 2024).

[40] Toxic-Free Future (2024) *Retailers committing to phase out PFAS as a class in food packaging and products.* Available at: https://toxicfreefuture.org/mind-the-store/retailers-committing-to-phase-out-pfas-as-a-class-infood-packaging-and-products/#fast-food (Accessed: 19 September 2024).

[41] European Commission (2024) *Proposal for a regulation on packaging and packaging waste.* Available at: https://environment.ec.europa.eu/publications/proposal-packaging-and-packaging-waste_en (Accessed: 19 September 2024).

[42] Department of Ecology (2022) *Per-* and polyfluoroalkyl substances in food packaging: *second* alternatives *assessment*. Available at: https://apps.ecology.wa.gov/publications/documents/2204007.pdf (Accessed: 27 September 2024).

[43] United Nations Environment Programme (UNEP) (2024) *Chemicals of concern in plastics proposal by Cook Islands, Rwanda and Norway.* Available at: https://resolutions.unep.org/incres/uploads/chemicals_of_concern_in_plastics_proposal_by_cook_islands_rwanda_and_norway.pdf (Accessed: 19 September 2024).

[44] SGS (2020) *Denmark bans PFAS chemicals in food contact paper and board.* Available at: https://www.sgs.com/en/news/2020/05/safeguards-07320-denmark-bans-pfas-chemicals-in-food-contact-paperand-board (Accessed: 19 September 2024).

[45] European Parliament (2024) *European Parliament legislative resolution of 24 April 2024 on the proposal for a regulation of the European Parliament and of the Council on packaging and packaging waste.* Available at: https://www.europarl.europa.eu/doceo/document/TA-9-2024-0318_EN.html (Accessed: 19 September 2024).

[46] U.S. Food and Drug Administration (2020) *FDA announces the voluntary phase-out by industry of certain PFAS used in food packaging*. Available at: https://www.fda.gov/food/cfsan-constituent-updates/fdaannounces-voluntary-phase-out-industry-certain-pfas-used-food-packaging (Accessed: 19 September 2024).

SYSTEMIQ

Learn more at **www.systemiq.earth** and
please contact us at **plastic@systemiq.earth**