

Q-Series

How will tightening 'forever chemicals' (PFAS) regulation impact the manufacturing sector?

Regulation of PFAS (~10k chemicals) is tightening and its scope is expanding

Tightening Per- and Polyfluoroalkyl Substances (PFAS) regulation globally has the potential to impact not only PFAS producers, but the majority of manufacturing industry categories. While the fluorochemical market is estimated at only US\$20-28bn/yr, roughly half of all industries include companies that use PFAS, amounting to a total market cap of US\$30trn. The EU is considering a ban of the PFAS group altogether, the US is considering stringent PFAS level limits for water, 3M has decided to [exit from PFAS](#) with clarity on litigation emerging with the recent [US\\$10.3bn settlement](#), and Japan and the UK are considering regulations as well. In this report we integrate insights from 13 industries across North America, Europe, and Asia on PFAS risks and opportunities.

Our base case: a total PFAS ban looks unlikely outside the EU

Although countries are in various stages of regulating PFAS, the most important developments to follow in order to gauge impact on companies are 1) water quality regulations in the US, and 2) production/sale regulations in the EU. Our global base case for regulation is that water quality rules tighten significantly in developed countries, and these not only cover the historical pollutants PFOS and PFOA but several other types that are currently in use. Apart from the EU, we think it is unlikely that countries would ban all PFAS production/use/sales at once given the language of current strategies. It would be more likely that several types of PFAS where associations with negative health impacts have been made would be banned in developed countries first and eventually added to the UN list of Persistent Organic Pollutants.

Impact not recognized yet for Asia/global PFAS users

Although PFAS risk is recognized for EU/US producers of PFAS (3M, Chemours, BASF, etc), it is less recognized in Asia, and less understood for PFAS user industries, substitute producers, and removal & clean-up services. Potential catalysts for pricing in PFAS risks/opportunities are new PFAS toxicity research results and news on regulatory developments (expected towards late 2023 to early 2024). In a tail risk scenario, these catalysts could trigger consumer boycotts or litigation.

Identifying key opportunities and risks

Chemicals, multi-industry, and HVAC face lower sales, but more importantly ongoing litigation risks (e.g. Chemours, Daikin). Some chemicals firms (e.g. Tosoh, Dow) are more favourably positioned since they offer substitutes. Semiconductor and tech hardware sectors have the potential to be most negatively impacted among PFAS users due to the lack of PFAS alternatives for semiconductor manufacturing. Other PFAS users such as apparel, cosmetics, food and food packaging will likely face limited impacts overall, but relative positioning within the sector could be impacted as regulations or consumer awareness come into play. Among companies removing and testing for PFAS such as water utilities and environmental services, the largest companies in the sector are favourably positioned due to the regulatory tailwind for industry consolidation. Water treatment companies and filter manufacturers also stand to benefit. We summarize the key sector impacts in [Figure 2](#), as well as most and least favourably exposed companies regarding tightening PFAS regulation looking at the next five years.

Equities

Global
Chemicals

Leigha Miyata

Analyst

@ubs.com

Victoria Kalb

Analyst

@ubs.com

Geoff Haire

Analyst

@ubs.com

Joshua Spector, CFA

Analyst

@ubs.com

Shunta Omura

Analyst

@ubs.com

Chris Snyder, CFA

Analyst

@ubs.com

Hikaru Mizuno

Analyst

@ubs.com

Gregg Orrill

Analyst

@ubs.com

Jon Windham, CFA

Analyst

@ubs.com

Francois-Xavier Bouvignies

Analyst

@ubs.com

Kenji Yasui

Analyst

@ubs.com

Shingo Hirata, CFA

Analyst

@ubs.com

Contents

Executive Summary	4
What are PFAS (in a nutshell)	8
Scenarios	10
Current regulatory landscape	13
Current innovation landscape	17
Sector Impact	19
Global Chemicals	24
US Multi-Industry	26
Global Heating Ventilation and Air Conditioning (HVAC)	28
US Water Utilities	30
North America Environmental Services	32
Global Semiconductors	34
Japan Tech Hardware	35
Japan Electronic Components	36
US Softlines	37
European Apparel Retail	39
Japan Retail	41
Korea Cosmetics	42
Japan Cosmetics	43
China Cosmetics	44
US Household & Personal Care/ US Beverages	45
US Restaurants	47
US Packaged Food	49
China Food and Beverage	51
What is PFAS (in detail)	52
Which chemicals are included in the PFAS group?	52
What are the properties of PFAS?	53
What is PFAS used for?	53
How much PFAS are used and emitted?	55

Leigha Miyata

Analyst

@ubs.com

Victoria Kalb

Analyst

@ubs.com

Geoff Haire

Analyst

@ubs.com

Joshua Spector, CFA

Analyst

@ubs.com

Shunta Omura

Analyst

@ubs.com

Chris Snyder, CFA

Analyst

@ubs.com

Hikaru Mizuno

Analyst

@ubs.com

Gregg Orrill

Analyst

@ubs.com

Jon Windham, CFA

Analyst

@ubs.com

Francois-Xavier Bouvignies

Analyst

@ubs.com

Kenji Yasui

Analyst

@ubs.com

Shingo Hirata, CFA

Analyst

@ubs.com

Jay Sole

Analyst

@ubs.com

Sreedhar Mahamkali

Analyst

@ubs.com

What are the main PFAS substitutes?	57
What are the Health & Environmental Effects of PFAS	59
Regulation (by country/region)	61
PFAS Litigation	65
PFAS Levels Data.	68
Appendix.	70
Main PFAS subgroups	70
PFAS related UBS publication list	71

Nozomi Moriya

Analyst

@ubs.com

Jaehyung Choi

Analyst

@ubs.com

Hisae Kawamoto

Analyst

@ubs.com

Ingrid Zhang

Analyst

S1460517080003

@ubs.com

Peter Grom

Analyst

@ubs.com

Dennis Geiger, CFA

Analyst

@ubs.com

Cody Ross

Analyst

@ubs.com

Mark Yuan

Analyst

S1460521050001

@ubs.com

Shneur Z. Gershuni, CFA

Analyst

@ubs.com

Camille Wynter

Analyst

@ubs.com

Neal Burk

Analyst

@ubs.com

Damian Karas, CFA

Analyst

@ubs.com

Amily Guo

Analyst

S1460518050002

@ubs.com

Harry Blaiklock, CFA

Analyst

@ubs.com

Mauricio Serna, CFA

Analyst

@ubs.com

Executive Summary

What's changing?



Regulation of PFAS, a group of ~10,000 chemicals, is tightening in many developed countries, and the way the chemicals are regulated is changing in Europe. Around 250 types of PFAS are said to be commercially relevant and are currently used throughout the global economy from semiconductors to cosmetics. Overall, the fluorochemical market is estimated to be US\$20-28bn per year⁽¹⁾. Roughly half of all industries include companies that use PFAS, and the total market cap of these industries amounts to approximately US\$30trn⁽²⁾. Even though 3 specific chemical substances (let us call them "Stockholm 3") known as PFOS, PFOA, and PFHxS (e.g. used in firefighting foam, non-stick cookware, metal plating) have already been banned or are being phased out in most countries, tightening PFAS regulation can have significant impacts on companies through the following channels. 1. reduced demand for PFAS (chemicals & HVAC⁽³⁾ sector), 2. increased demand for PFAS alternatives (chemicals & HVAC sector), 3. increased compliance costs (removal, testing/developing substitutes in most sectors including water utilities, semis/tech hardware, apparel, cosmetics, food processing/packaging, automotive, HVAC), 4. increased demand for PFAS management and removal (environmental services & filter-makers), 5. litigation and remediation costs from both past and current production and use of PFAS (chemicals & HVAC sector), 6. changes in market share based on early adoption of PFAS-free products (most sectors such as those mentioned in 3).

Scenarios - How could this play out?

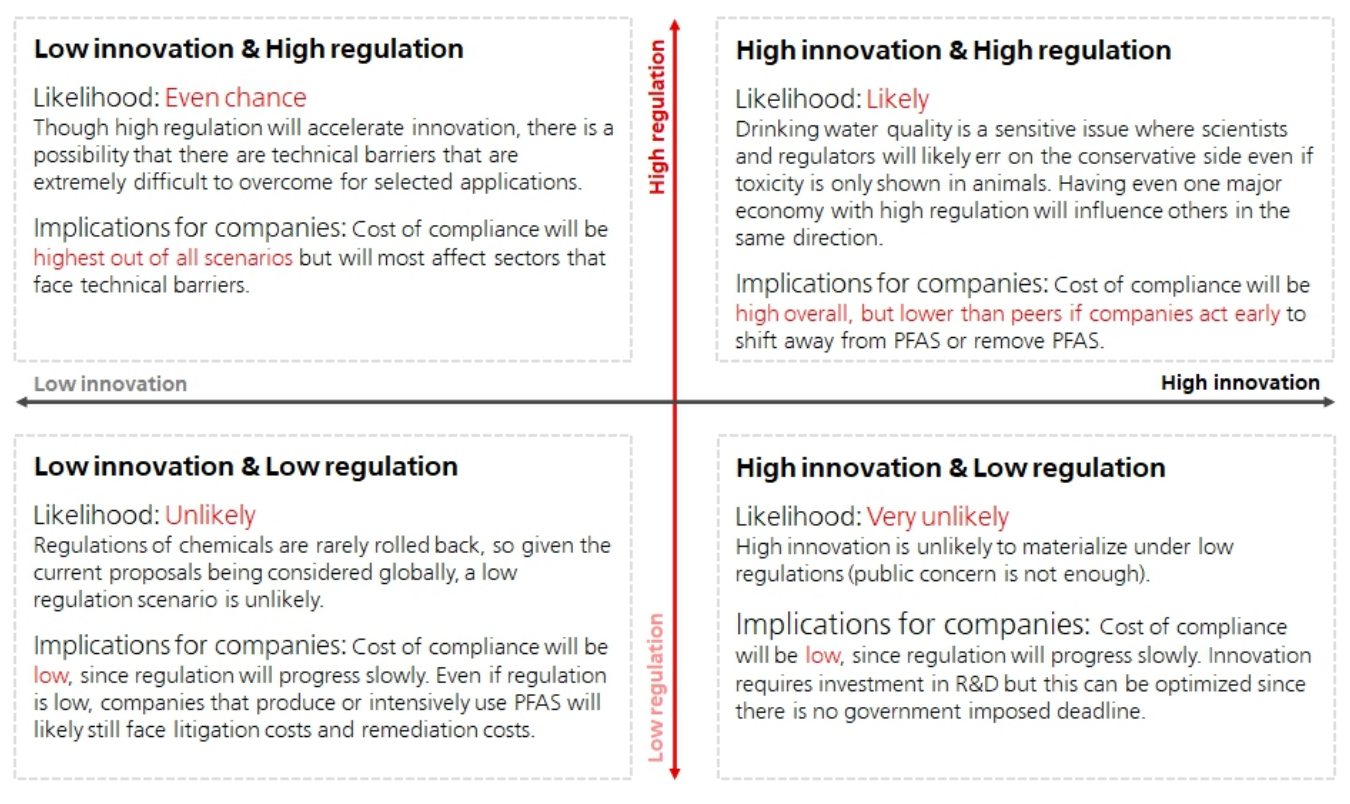
We explore four theoretical scenarios going forward depending on the level of regulation and the level of innovation globally. We see High innovation & High regulation as likely, Low innovation & High regulation as even chance, Low innovation & Low regulation as unlikely, and High innovation & Low regulation as very unlikely (see [Figure 1](#) for our reasoning). We also suggest a global base case scenario based on prior regulatory trends, although in reality, the level of regulation will differ by country and the speed of innovation will differ by type of use. Our global base case is that there will be significantly stricter water limits for PFAS in most countries, but outright production/use bans for only a limited number of PFAS outside of the EU.

Only a handful of large corporations globally have started preparing for PFAS regulations (Inditex, 3M etc.), and the potential impact from tightening regulation is high for a limited number of companies with high exposure to the issue. Most sectors such as apparel, cookware, and cosmetics have viable alternatives to PFAS even if some will be more costly or less functional.

The expected regulatory timeline assuming regulation proceeds is shown in [Figure 8](#). The US drinking water limits are expected to become effective first in 2026, followed by the EU blanket ban on PFAS use and sale from 2026/27.

-
1. Estimates from 9 market reports (2018-22) collected by chemsec (<https://chemsec.org/reports/the-top-12-pfas-producers-in-the-world-and-the-staggering-societal-costs-of-pfas-pollution/>)
 2. Bloomberg market cap as of 2023/6/19 for 16 industry/sub-industry categories within 6 BICS sectors (Consumer discretionary, consumer staples, healthcare, industrials, materials, and technology).
 3. Heating Ventilation and Air Conditioning

Figure 1: Likelihood and implications of each scenario; high innovation & high regulation looks the most likely of the four



Source: UBS

Sector impact - How to position?

Although countries are in various stages of regulating PFAS, the most important developments to follow in order to gauge impact on companies is 1. water quality regulations in the US, and 2. production, use, sale, and trade regulations in the EU. We summarize the key sector impacts in [Figure 2](#), as well as most and least favourably exposed companies regarding tightening PFAS regulation looking at the next five years.

Chemicals, multi-industry, and HVAC face lower sales, but more importantly ongoing litigation risks. Some companies in these sectors that produce alternatives to PFAS and PFAS removal technologies are more favourably positioned. Environmental services stand to benefit, and we expect regulations to be a tailwind for M&A among water utilities. Semiconductor and tech hardware sectors have the potential to be most negatively impacted among PFAS users due to the lack of PFAS alternatives for semiconductor manufacturing. We think semiconductors are likely to receive a 12-year derogation under the ECHA PFAS ban as explained in [Sector Impact](#) on p19. Other PFAS users such as apparel, cosmetics, food and food packaging will likely face limited impacts overall, but relative positioning within the sector could be affected as regulations or consumer awareness come into play.

Given how wide-reaching the proposed PFAS ban in the EU is, it may be surprising that many of the arrows in the table below are flat (yellow, no significant change). However, it is important to note that [Figure 2](#) does not show tail risks. Significant tail risks are possible for PFAS producers in the form of litigation, PFAS users in the form of sudden boycotts or litigation (see [PFAS Litigation](#) for examples), and all related sectors in the form of sudden or extremely strict regulations (e.g. PFAS ban in the US, no derogation for semiconductors in the EU). Although these scenarios are not our base case, they are not so far fetched either. For example, the US EPA published its "PFAS Strategic Roadmap" in October 2021, which includes the objectives "Use and harmonize actions under all available statutory authorities to control and prevent PFAS contamination and minimize exposure to PFAS during consumer and industrial uses," and "Establish voluntary programs to reduce PFAS use and release."

Figure 2: Sector impact summary

Sector	Region	Exposure	Growth	Margins	ROIC	Valuation	Most favourable	Least favourable
Chemicals	Global	Production/use (c.1 % of sales)	↘	↘	↘	↘	Kuraray, Tosoh, Wacker Chemie, Dow	Arkema, BASF, Clariant, Solvay, Chemours, Dupont
Multi-Industry	US	Mostly past sale/use of PFAS	↘	↗	↗	↘	Pentair, AO Smith	3M
Heating Ventilation and Air Conditioning	Global	Production/use (Daikin chemical business 7% of sales)	→	↘	→	→		Daikin Industries
Water Utilities	US	Potentially affects all water supply	↗	→	→	↗	American Water Essential Utilities	Public Water Systems
Environmental Services	North America	Removal tech/services less than 5% of sales	↗	→	↗	→	Clean Harbors, Waste Management, Republic Services	OPAL
Semiconductors / Tech Hardware	Global	Current use (c.20-100% of sales)	→	↘	↘	↘		Across the semi industry
Electronic Components	Japan	No disclosure (likely used widely)	→	↘	↘	↘		Rohm, Ibiden, Shinko Electric
Softlines	US	Current use	→	→	→	→	Deckers, Levi's, Signet Jewelers	Macy's, Nordstrom, Kohl's
Apparel	Europe	Past use only	→	→	→	→	Inditex, Zalando, AboutYou	
Retail	Japan	Current use	→	→	→	→	Fast Retailing	
Cosmetics	Korea, Japan, China	Current use (approx. 1-1.5% of sales)	→	→	→	→	Amorepacific, LG H&H, Shiseido, Kose, Botanee, Proya, Bloomage	
Household & Personal Care / Beverages	US	Current use (insignificant as a % of sales)	→	↘	↘	→	Yeti, beverage companies	Estee Lauder, Procter & Gamble
Restaurants	US	Current use (insignificant as a % of sales)	→	→	→	→	The Cheesecake Factory, Bloomin' Brands, Texas Roadhouse	Restaurant Brands International, Yum! Brands, McDonald's
Packaged Food	US	Current use (insignificant as a % of COGS)	→	↘	↘	→	Nomad Foods, Mondelez International	The Hershey Company, Conagra Brands
Food & Beverage	China	Current limited use	→	→	→	→	Yili, Mengniu	

Source: UBS

This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Figure 3: High-level summary of types of base case regulation impact on each sector

		Lower revenue	Higher revenue	Litigation risk	Substitute related costs	Removal cost	M&A tailwind	Awareness & disclosure
Producing PFAS (& substitutes)	Chemicals / multi-industry	✓	(for substitute manufacturers)	✓✓✓	✓	✓✓✓		moderate
	Heating Ventilation and Air Conditioning	✓	(for substitute manufacturers)	✓✓	✓	✓✓✓		low
Test & remove	Water Utilities		✓✓			✓✓	✓✓	-
	Environmental Services		✓✓			✓✓	✓✓	-
Using PFAS	Semiconductors				✓	✓		low at company level
	Electronic Components				✓	✓		low
	Apparel				✓			low outside EU
	Cosmetics			✓	✓			low
	Food & Beverage			✓	✓			low
	Restaurants							low
	Other retail				✓			low

Source: UBS based on Sector Impact pages and ECHA Evidence Review

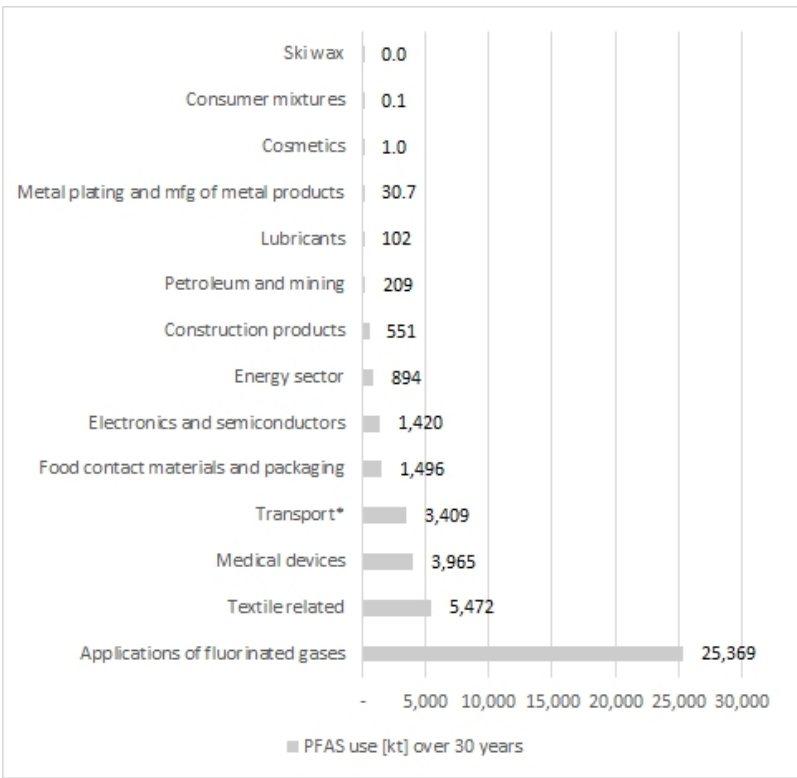
Note: The number of check marks denotes the significance of potential impact on the sector based on contributions from sector analysts and the ECHA Evidence Review.

What are PFAS (in a nutshell)

'Forever chemicals' is a term coined by Harvard University Professor Joseph Allen to refer to manufactured chemicals that do not easily break down and can build up in people, animals, and the environment. Although several groups of chemicals can be described this way, this report focuses on PFAS. Per- and Polyfluoroalkyl Substances (PFAS) are a group of manufactured chemicals, used since the 1940s. The European Chemicals Agency defines the scope of the PFAS restriction similarly to the OECD definition. "Any substance that contains at least one fully fluorinated methyl (CF₃-) or methylene (-CF₂-) carbon atom (without any H/Cl/Br/I attached to it)" with a few fully degradable subgroups excluded ([ECHA proposal](#)). The carbon-fluorine bond is the strongest known covalent bond in organic chemistry and complete breakdown of PFAS takes years to thousands of years⁽⁴⁾. Of the thousands of PFAS types, around 250 are commercially relevant and 3 are listed as Stockholm Convention Persistent Organic Pollutants (see [Figure 5](#)). In this report, we refer to these 3 types of PFAS as "Stockholm 3". The most commonly used and studied examples in the PFAS group are Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS). The EU ban proposal estimates that "around 4.5 million tonnes of PFASs would end up in the environment over the next 30 years unless action is taken." (EU [ECHA](#))

What are PFAS used in? Products and processes where water and oil-repellent properties are needed, especially in high temperature, high pressure, or acidic environments. Some examples include waterproof textiles, plastics, paint, cookware, cosmetics, fire extinguishers and electronic equipment. See [Figure 24](#) & [Figure 25](#) for a more comprehensive list. Public awareness and concern are likely rising due to media reporting on PFAS in [freshwater fish](#), [food packaging](#), [dental floss](#), and [contact lenses](#).

Figure 4: Estimated PFAS use in the EU over the next 30 years



Source: UBS based on ECHA PFAS Restriction Proposal Annex XV, European Chemicals Agency, <http://echa.europa.eu/>
Note: * Transport PFAS use and emissions are mostly counted under "Applications of fluorinated gases." Cosmetics assumes a worst case scenario with 100% going to waste water

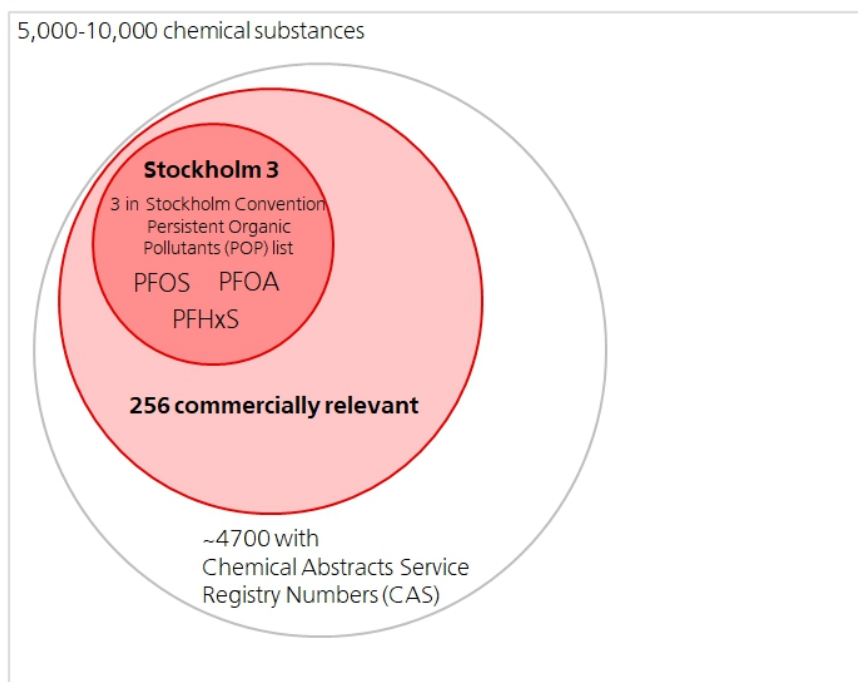
4. ECHA proposal Annex B

What are the health-effects of PFAS in humans? While health effects are difficult to determine, we note the potential seriousness of health conditions identified by peer-reviewed research. The main research challenges include: the existence of many types of PFAS, the types of PFAS used having changed overtime, PFAS accumulation overtime, and the many different ways PFAS exposure can occur. Health impacts cited by the EPA include: lower fertility, developmental effects in children, increased risk of prostate, kidney, and testicular cancer, reduced immunity and vaccine response, among others. See [health impacts](#) for a more comprehensive explanation.

What are the environmental effects of PFAS? Although health effects of less studied PFAS types are unclear, the persistence of almost all PFAS in one form or another is well established. The EU proposal classifies PFAS as "highly persistent," and emphasizes the need to restrict PFAS at the source due to the problem of PFAS accumulation in the environment and organisms. To date, PFAS has been detected in mammals, fish, plant leaves, water bodies, and arctic ice among others (ECHA proposal Annex B). Although activated carbon and high pressure membranes are recognized as ways to remove some PFAS from drinking water (US EPA proposal), the EU proposal states that PFAS can be highly mobile, that it is difficult to decontaminate water or sites at a large scale, and that an end-of-pipe solution is unachievable since PFAS is contained in many industrial and consumer products. See [environmental impacts](#) for a more comprehensive explanation.

Figure 5: Of the thousands of PFAS, around 250 are commercially relevant and 3 are listed as Stockholm Convention Persistent Organic Pollutants ("Stockholm 3")

PFAS Per- and Polyfluoroalkyl Substances



Source: UBS based on ITRC (Interstate Technology & Regulatory Council). 2022. PFAS Technical and Regulatory Guidance Document and Fact Sheets PFAS-1. Washington, D.C.: Interstate Technology & Regulatory Council, PFAS Team. <https://pfas-1.itrcweb.org/>.

Scenarios

We explore four theoretical scenarios going forward depending on the level of regulation and the level of innovation. We suggest a global base case scenario based on prior regulatory trends, although in reality, the level of regulation will differ by country and the speed of innovation will differ by type of use. Our base case is that there will be significantly stricter water limits for PFAS in most countries, but outright production/use bans for only a limited number of PFAS.

1. Low innovation & Low regulation

In this scenario, regulation continues along its trajectory prior to 2021. PFAS bans are only adopted as specific chemicals in the group are added to the Stockholm Convention on Persistent Organic Pollutants (POPs). Currently, PFOS, PFOA, and PFHxS are on the POPs list, and are banned in most developed countries. Chemicals will only be banned if sufficient evidence of persistence and accumulation is compiled for that specific chemical, so only those that have been widely used for a significant number of years would be at risk of a ban. PFAS in drinking water is a more sensitive topic so even in a low regulation scenario, we expect some countries to further restrict PFAS levels in drinking water. However, such changes will be slow and limited to a handful of developed countries.

Partly due to the low regulation, substitute development lags for semiconductor manufacturing, firefighting foams for defence, textiles for industrial and medical use, and hard chrome plating. Technology for PFAS breakdown is not commercialized, and various types of PFAS continue to accumulate in the environment.

2. High innovation & Low regulation

Regulation is low as described in the previous scenario. However, innovation takes place despite the lack of pressure from regulators due to pressure from the demand side. Consumers and workers may push for PFAS-free products, similarly to an increasing preference for BPA-free plastic containers and concern from firefighters (demanding [PFAS-free gear](#) and [work exposure](#)) and local communities on health hazards. Given [Apple's commitment](#) to phase out PFAS and [H&M's ban on PFAS](#) in clothing and cosmetics it produces, similar actions by major corporations are possible and would encourage suppliers to develop alternatives. See [Current innovation landscape](#) for a list of PFAS alternatives.

In addition to chemical alternatives to PFAS, more companies may offer chemical-free alternatives that meet the same consumer needs (e.g. PFAS-free dental floss or pressurized water flossers). In some applications such as semiconductor manufacturing and firefighting foams for defence, alternatives may take time to develop, so there will be a need for technology that removes PFAS from water and soil, and technology for breaking down PFAS once it is collected. In this scenario, PFAS removal and breakdown technologies such as the one developed by [Canadian researchers](#) are commercialized and widely available.

3. Low innovation & High regulation

In this scenario, the ban for all types of PFAS goes ahead in the EU with some sectors exempted for 6.5 or 13.5 years, and several other countries/states/provinces follow the EU's path. PFAS levels allowed in drinking water are set at a very low level such as those proposed by the US EPA. Drinking water regulation covers all PFAS in countries with a blanket ban, although the difficulty in measuring low PFAS levels and specific types of PFAS will likely shape how drinking water PFAS limits are defined. If stricter drinking water regulation is supported, it is likely that discharge of water and waste from manufacturing plants in countries without blanket bans would be regulated as well. This would be a supportive environment for adding several other types of PFAS in the UNEP [POP list](#), thus restricting a wider range of PFAS use over time in the 186 parties that have ratified the Stockholm Convention.

Despite high levels of regulation, substitute and removal/breakdown technology development may lag due to technical barriers. For example, the [International Semiconductor Association states](#) that "Research is actively ongoing into substitutes for

PFAS in the semiconductor industry, but to date, no suitable alternatives have been found that successfully replace many of the essential uses of PFAS in the chip manufacturing, equipment, and infrastructure. (...) A typical semiconductor process technology change timeline is at least 10-15 years to fully qualify and integrate solutions". In this Low innovation & High regulation scenario, industries that face technical barriers to alternative development are either successful in lobbying for delayed implementation of the rule, or face high PFAS removal and destruction costs as well as high litigation risk.

4. High innovation & High regulation

As explained above, a high regulation scenario entails a blanket ban on PFAS in the EU and several other areas, much lower PFAS levels allowed in drinking water than current guidelines, and development of regulations of PFAS in waste. High regulation will accelerate the development and use of PFAS alternatives, removal and breakdown technology. If this scenario plays out in even a single major economic area, it is likely to make PFAS regulations easier to adopt elsewhere since high regulation will increase resources allocated to alternative development, alternatives become increasingly available, and this lowers the cost and opposition to regulation.

Base Case

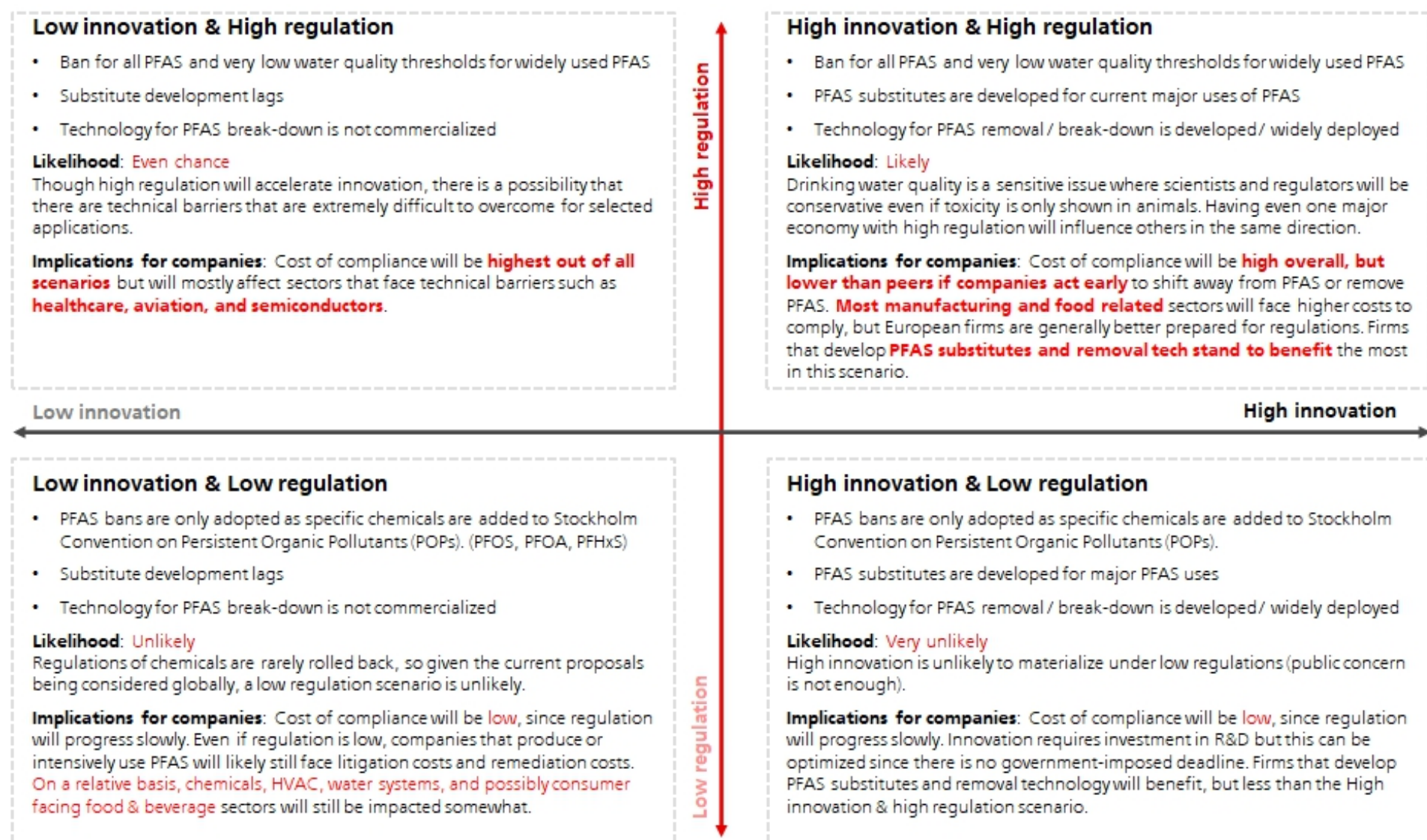
Of the four scenarios, we see High innovation & High regulation as likely, Low innovation & High regulation as even chance, Low innovation & Low regulation as unlikely, and High innovation & Low regulation as very unlikely (see [Figure 6](#) for our reasoning). However, since these are all extreme cases to highlight the universe of possibilities, we suggest a baseline scenario below and in [Figure 7](#).

Although the situation will differ by country, our global base case on the regulation axis is "moderately high regulation." Innovation will differ by product type, but given alternatives already exist for most applications for PFAS, it seems unlikely that alternatives will be impossible to develop. The challenge seems to be the time it would take for substitute development, testing, certification in industries where safety and precision are extremely important such as healthcare, food processing, automotive, aviation, and semiconductors. See [Current innovation landscape](#) p.17 for a list of PFAS alternatives.

Base case level of regulation for water quality: The US and Canada have set out proposals for new PFAS limits in water. We expect similar proposals in most other developed countries. Water level limits will not only cover PFOS and PFOA but several other types such as PFHxS, GenX, PFNA, PFHxA and PFBS.

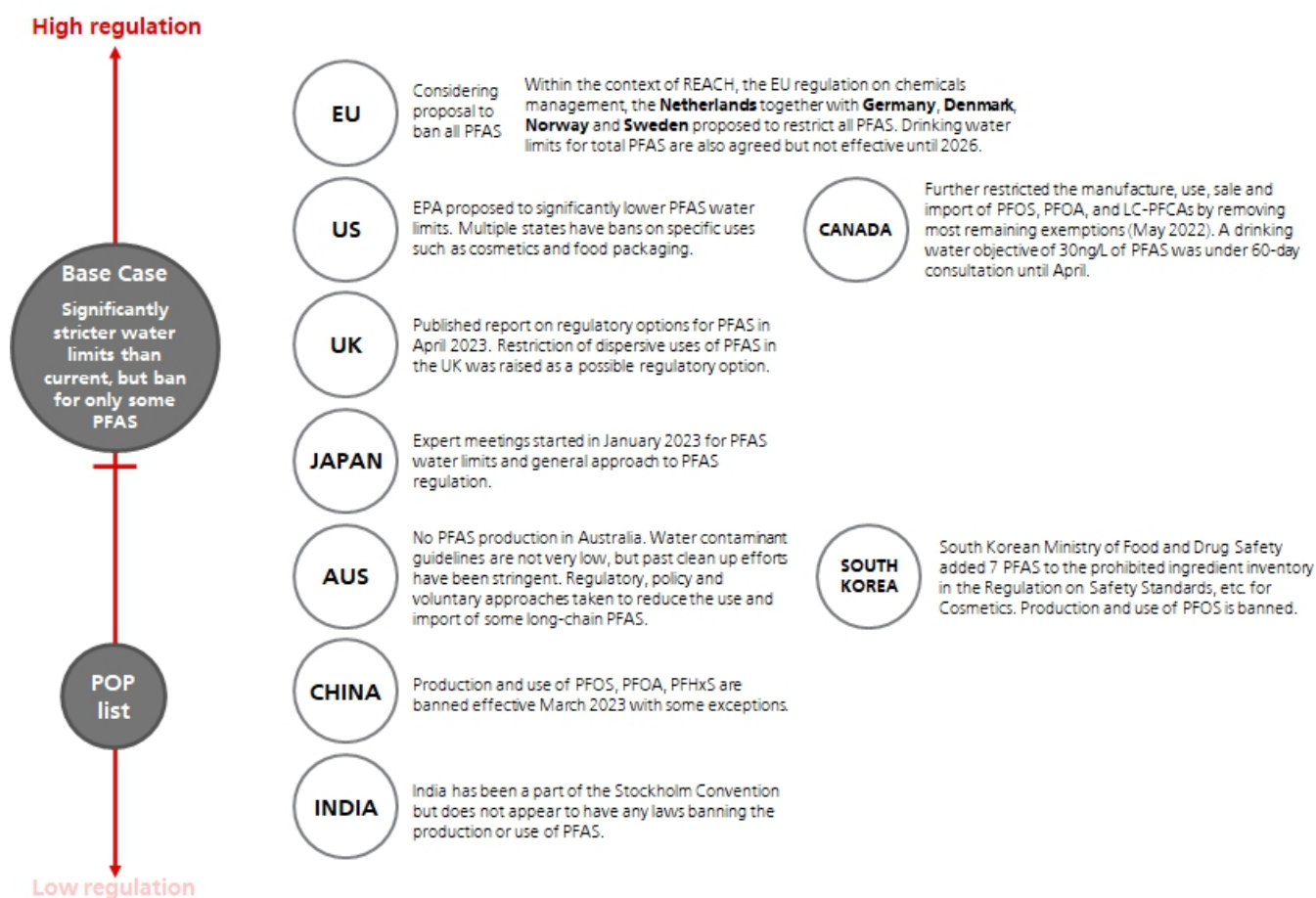
Base case level of regulation for production, use and trade: The UNEP Persistent Organic Pollutants (POP) list already includes PFOS, PFOA and PFHxS, so these are mostly already banned (production/use) in developed countries and some developing countries. Apart from the EU, it is unlikely that most countries will ban all PFAS at once. It is more likely that several types of PFAS where associations with negative health impacts have been made (e.g. PFDA, PFNA) will be banned in developed countries before they are added to the POP list. See [Figure 32](#) for a summary of studies on PFAS toxicity.

Figure 6: Likelihood and implications of each scenario; High innovation & High regulation is the most likely of the four



Source: UBS

Figure 7: Regulation base case "moderately high regulation" and regulations in selected countries



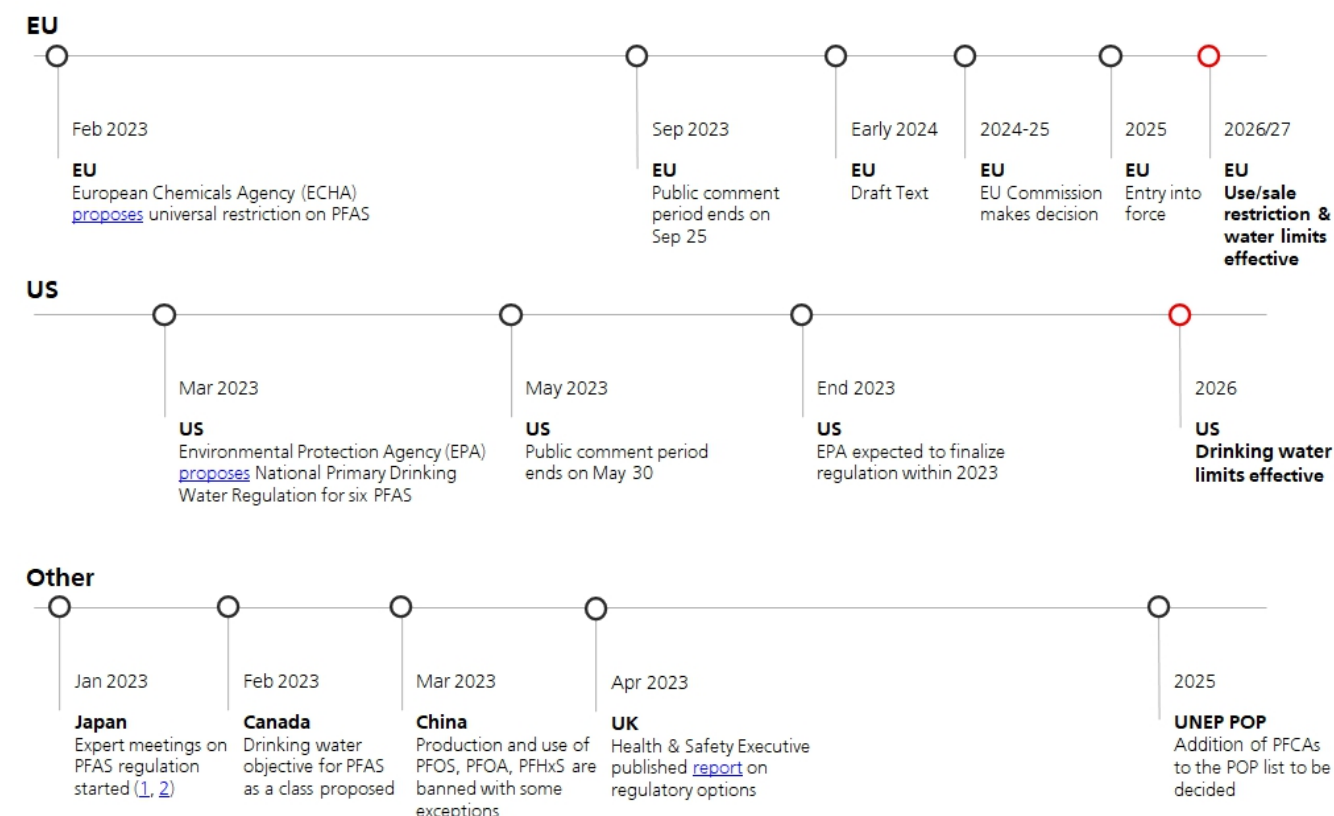
Source: UBS based on [OECD](#), EU (ECHA), US (EPA), UK (HSE), China ([Envilience](#)), Canada ([report](#)), Asia ([Cosmetics Regulations](#)), Japan ([MoE](#))

Current regulatory landscape

The two main types of PFAS regulation are 1. water quality regulations and 2. production, use, sale, and trade regulations. Although countries are in various stages of regulating PFAS, the most important developments to follow in order to gauge impact on companies is 1. water quality regulations in the US, and 2. production, use, sale, and trade regulations in the EU.

The expected regulatory timeline assuming regulation proceeds is shown in [Figure 8](#). The US drinking water limits are expected to become effective first in 2026, followed by the EU blanket ban on PFAS use and sale from 2026/27. The EU ban is expected to enter into force in 2025, but all sectors have an 18-month window for preparation before the restriction becomes effective, and some sectors will have an extra 5 or 12 years to develop alternatives to PFAS. Other countries such as Japan, the UK, and Canada are also considering regulations.

Figure 8: Expected regulatory timeline assuming regulation proceeds



Source: UBS, based on EU ECHA, US EPA, Japan MoE, UK HSE

Figure 9: PFAS regulations by country/region (* denotes proposal)

	Water	Use/sale	Covering more than Stockholm 3?	PFAS types limited or banned
EU	Limits for 20 or all PFAS	Blanket ban*	Yes	All
US	Limits for 6*		Yes	PFOS, PFOA, PFNA, PFHxS, HFPO-DA, PFBS
Canada	Objective for all PFAS*	Ban for 3 groups	Yes	PFOS, PFOA, and LC-PFCAs
UK	Advisory levels for 2 PFAS (Limit for 20 PFAS in Scotland)	Early-stage consideration started for wide dispersive uses*	Yes for water in Scotland	Scotland: PFBA, PFPA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFBS, PFPS, PFHxS, PFHpS, PFOS, PFNS and 4 others
Thailand	-	Ban for 2 groups	Yes for cosmetics*	Cosmetics: 13 including PFOS and related substances, PFOA and related substances, PFNA
South Korea	-	Ban for 1 group	Yes for cosmetics*	PFOS, its salts and PFOS-F, Cosmetics: 7 specific substances including PFNA
Japan	Provisional guide for 2 PFAS being re-evaluated*	Ban for 3 groups*	No (PFHxS expected in 2024*)	PFOS, its salts and PFOSF, PFOA, its salts (PFOA related compounds, PFHxS and its salts expected in future)
China	-	Ban for 3 groups	No	PFOS, its salts, and PFOSF, PFOA, its salts, PFOA related compounds, PFHxS, its salts, PFHxS related compounds
Vietnam	-	Ban for 2 groups*	No	PFOS, its salts and PFOSF, PFOA, its salts, PFOA related compounds (PTFE, PVDF, FEP)

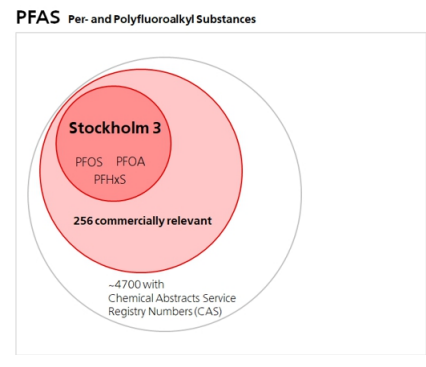
Source: UBS based on [OECD](#), Vietnam ([Envilience](#), [SGS](#)), China ([Envilience](#)), Canada ([report](#)), Thailand ([Chemical watch](#)), Asia ([Cosmetics Regulations](#)), Japan ([MoE](#))

Water quality regulations in the US

Most developed countries have guidelines or advisories for the amount of certain types of PFAS in drinking water and/or water bodies (e.g. lakes, ground water). The US Environmental Protection Agency (EPA) included PFOS, PFOA, PFNA, PFHxS, PFHpA, and PFBS in its Third Unregulated Contaminant Monitoring Rule for drinking water in 2013, mandating the monitoring of these chemicals by public water systems that serve more than 10,000 customers. In 2016, the EPA reduced the lifetime drinking water health advisory limit for PFOA and PFOS from 400 and 200 respectively to a combined level of 70 parts per trillion (=nano grams per liter). As of January 2023, eight states (Massachusetts, Michigan, New Hampshire, New Jersey, New York, Pennsylvania, Vermont, and Washington) had set maximum contaminant levels for one or more PFAS. For example, in January 2023, Pennsylvania passed a maximum contaminant limit for PFOS and PFOA of 18 and 14 nano grams per liter respectively, to be effective in most areas from January 2024 ([PA rule](#)). Health advisories on PFAS levels in water mostly focused on PFOA and PFOS but the advisories became stricter (lower) by almost an order of magnitude at the federal level, and maximum contaminant limits were set by some states at an even lower level.

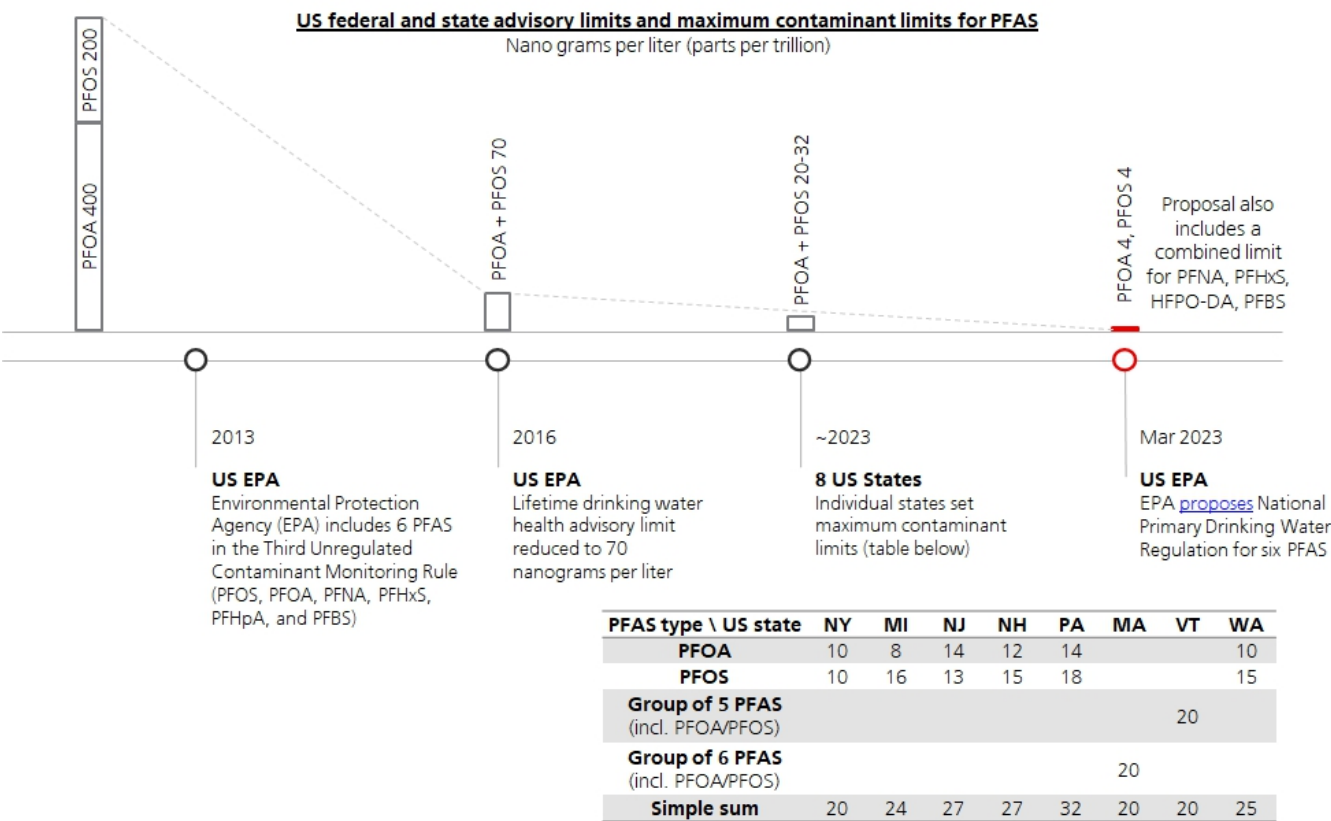
Despite the known general direction of lowering limits, the latest proposal in March 2023 by the US EPA was the most thoroughgoing and surprising from a layperson's view. The points to note are that 1. the new proposed limits are substantially lower than the previous advisory level, and 2. limits are proposed for 4 more types of PFAS other than PFOS and PFOA (namely, PFNA, PFHxS, HFPO-DA, PFBS). The first point is important as these limits make litigation and the need for clean-up/removal more likely and costly. It is also difficult to detect PFAS at very low levels, so there will be a need for testing equipment and services. The second point is especially important for a wide range of companies since the 4 types of PFAS mentioned above are currently produced and used, as opposed to PFOS and PFOA that have been banned in most developed countries. The proposal includes maximum contaminant limits (MCL) and maximum contaminant goals (MCLG) for 6 types of PFAS.

Figure 10: PFAS definition



Source: UBS

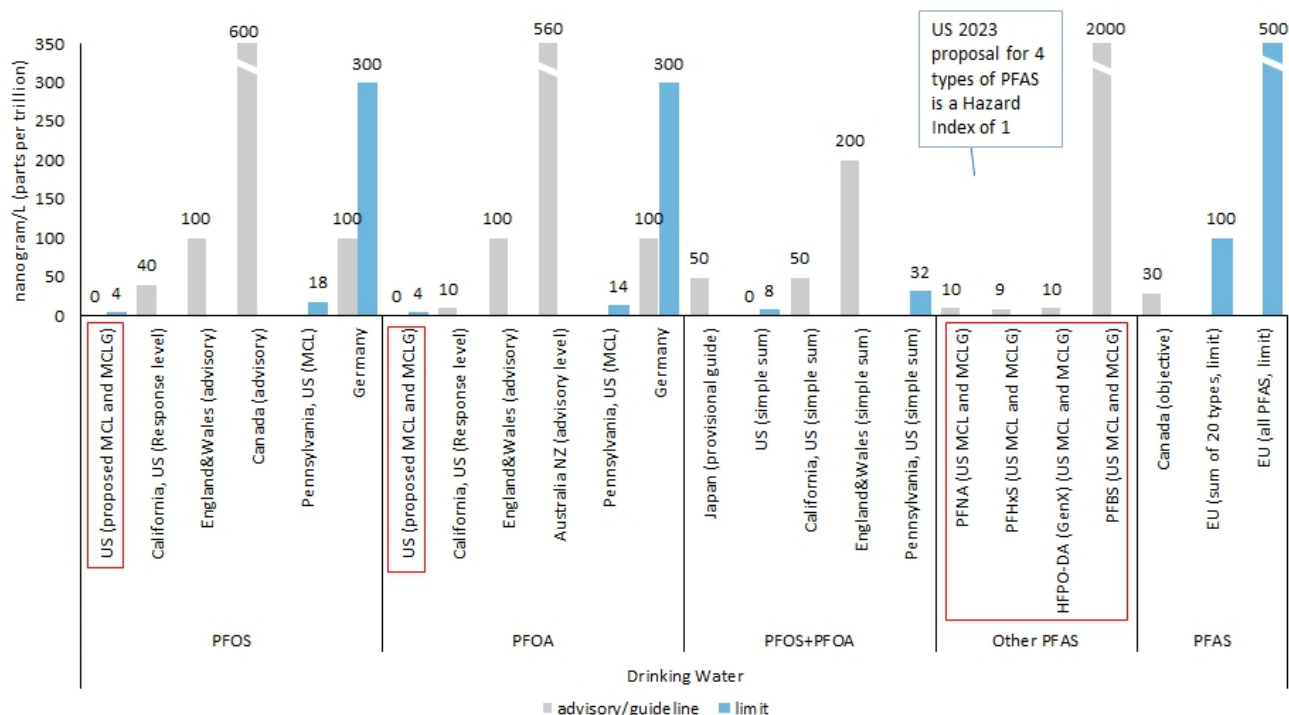
Figure 11: US water quality regulations



Source: UBS based on US EPA, Pennsylvania Safe Drinking Water PFAS MCL [Rule](#)

In [Figure 12](#) we compile selected standards for PFAS in drinking water and the environment. While this is not an exhaustive analysis, it illustrates the potential for future regulatory tightening, in our view, on the basis that some jurisdictions have maximum contaminant levels that cannot be exceeded, while others have advisories or guidelines, and that these levels vary widely on a global basis. It cannot be the case that all of these varied PFAS levels are "correct" from the perspective of toxicity for humans. The trend for developed countries is to 1. lower PFAS guideline levels, 2. introduce limits rather than just guidelines, 3. expand the scope of water level limits from PFOS and PFOA to other PFAS, a group of PFAS, or all PFAS.

Figure 12: Current drinking water advisory and maximum contaminant levels; many being reexamined



Source: UBS, based on US EPA, EU ECHA, Japan Ministry of Environment, Pennsylvania DEP, California Water Board
MCL: Maximum Contaminant Level, MCLG: Maximum Contaminant Level Goal

Production, use, sale and trade regulations in the EU

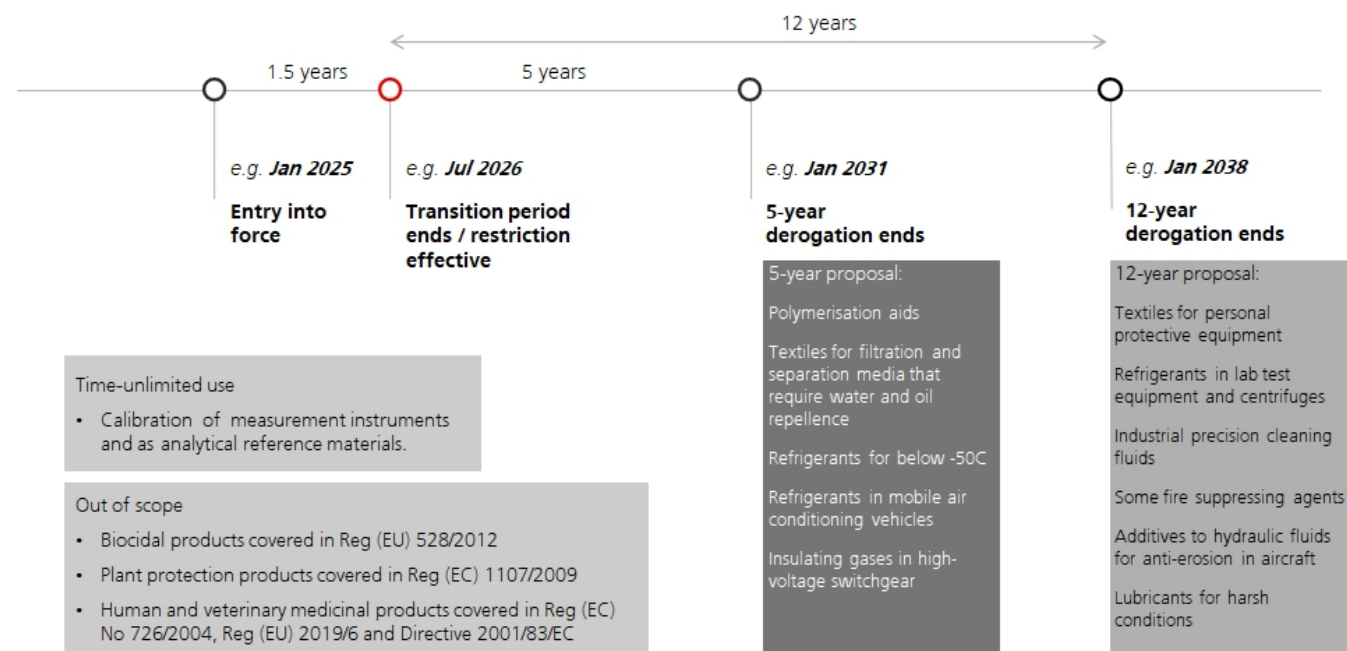
The European Chemicals Agency (ECHA) put forward a proposal in February 2023 to restrict the manufacture, use, and sale/import of PFAS or substances/articles containing PFAS above a certain concentration. The proposal includes two options (blanket ban only or blanket ban with longer transition periods for some uses), but the option recommended by ECHA is a "ban with use-specific derogations." As shown in [Figure 13](#), there will be a 1.5 year transition period following entry into force, after which all manufacture, use and placement on the market is banned. After the transition period ends, some uses will have an additional 5 or 12 years before the ban is applicable. The proposal currently suggests 26 uses that should be eligible for derogations, and 20 uses that are "potential derogations". Whether or not "potential derogations" become actual derogations in the final version of the regulation will depend on evidence received during the public consultation. Derogations are proposed based on the "non-existence of technically and economically feasible alternatives" before entry into force. Most of the proposed derogations can be grouped into those related to health (medical devices), safety (textiles for personal protective equipment), existing regulation (housing codes for air-conditioning), and extreme temperatures/conditions (refrigerants for -50°C or lower). See [Figure 34](#) for a full list of proposed derogations and potential derogations.

The key questions regarding the ECHA proposal to determine impacts on PFAS-using sectors are: 1. how quickly can PFAS alternatives be developed and at what cost; 2. how many "proposed derogations" or completely new derogations will be included in the final version of the regulation; and 3. could the derogations be extended beyond 12 years. If the opinions of industry and regulators are far apart on the first question, the

final regulation is more likely to cause a disruption by not having a derogation for an industry that is ill-prepared or face high switching costs. We take a closer look at the availability of PFAS alternatives in [Figure 14](#).

Figure 13: EU PFAS Restriction Proposal (Illustrative timeline for entry into force in Jan 2025)

Illustrative example timeline assuming entry into force in Jan 2025.



Source: UBS, based on EU ECHA Annex XV p24-28, European Chemicals Agency, <http://echa.europa.eu/>

Current innovation landscape

Evidence collected by the ECHA suggests that non-PFAS substitutes exist for most uses of PFAS as shown in [Figure 14](#), but the substitutes differ widely by use. Some uses do not have technically and economically feasible alternatives when looking at a time span of 2-4 years. Some such examples include industrial food and feed preparation, refrigeration below -50C, insulating gas in high voltage electrical equipment, most medical devices, most uses in transport (seals, gaskets, hydraulic fluids), and the semiconductor manufacturing process. Note that this does not translate into an automatic derogation in the ECHA PFAS restriction proposal. Semiconductor manufacturing and applications affecting the safe functioning of transport vehicles currently do not have a derogation proposed, and any derogation is subject to debate during the public comment period. That said, given the fact that the ECHA will have many parties lobbying for derogations at the same time, we believe that it will be difficult to scrutinize the evidence provided by industry during the limited time period, and the relative importance of some industries (i.e. semiconductors) may make it more likely that "potential derogations" will become actual derogations.

As mentioned above, PFAS substitutes differ widely by use, but the most commonly mentioned substances are dendrimers, hydrocarbons, and polyurethanes for textiles, silicones for textiles and cleaners, and ammonia (NH₃), carbon dioxide (CO₂) and hydrocarbons (propane or isobutane) for refrigerants.

Areas of research and development by the chemicals sector range from bio-based materials (from sugars and plant oils) to materials science / nanotechnologies using inorganic products (eg using tio₂ and siloxanes). Some companies are also exploring petrochemicals-based alternatives, which include polyurethane and polyester-based technologies. As specific examples, Solvay is working on a new polymerization process which is non-fluorosurfactant, and Perimeter Solutions has increasing sales of non-

fluorinated firefighting foams.

Besides using PFAS substitutes, companies can also innovate by shifting their product portfolio. In cosmetics for example, some companies market "natural" product lines and offer utility to customers by communicating safety and trustworthiness, even though shiny and smooth characteristics may be less due to lack of PFAS use. Similarly, in restaurants and food packaging, responding to environmental concerns of packaging waste by doing away with some packaging altogether might leave companies less exposed to any impacts of a PFAS ban.

Figure 14: PFAS substitutes - summary of ECHA evidence review

Sector	Use	Alternatives					Company Cost Impact
		Technical feasibility	Economic feasibility	No shortage	Functionality	Available	
Manufacture	Use of PFAS in manufacture of PTFE, PVDF, FKM	✓	✓	✓	-	currently	high
	Use of PFAS in manufacture of polymeric PFASs other than PTFE, PVDF, FKM	✓	✓	-	-	by 2032	high
Textile related	Home textiles	✓	✓	✓	lower	currently	low
	Consumer and professional apparel	✓	✓	✓	lower	currently	low
	Personal protective equipment	some	-	-	lower	currently	high for some
	Medical textile applications (mattress protectors, gowns)	?	-	-	-	-	high
Food contact materials and packaging	Consumer cookware	✓	✓	✓	-	currently	high for some
	Industrial food and feed preparation (valves, conveyer belts, electronics)	✗	-	-	-	-	high
	Non-stick coatings in industrial/professional bakeware	✓	✓	-	-	currently	low
	Paper & board packaging	✓	✓	✓	-	currently	high for some
	Plastic packaging (plastic film)	✓	✓	-	likely lower	currently	?
Metal & Mfg of metal	Hard chrome plating	✓	✓	-	-	currently	low
	Decorative plating	✓	✓	✓	-	currently	low
Consumer mixtures	Cleaners (for glass, metal, ceramic, carpet etc), dishwashing rinse aids	✓	✓	✓	-	currently	-
	Waxes (for floors/cars)	✓	✓	✓	-	currently	-
Applications for fluorinated gases	Cosmetics	✓	✓	✓	similar	currently	low
	Refrigeration (except below)	✓	✓	✓	similar	currently	low
	Refrigeration (below -50C, in test equipment, in centrifuges)	✗	-	-	-	-	high
	Air conditioning and heat pumps	✓	✓	✓	-	currently	low
	Foam blowing agents (for insulation)	✓	✓	✓	lower	currently	low
	Solvents	✓	✓	✓	-	currently	low
	Propellants	✓	✓	✓	-	currently	-
	Fire suppressants	some	-	-	lower	currently	-
	Insulating gas in electrical equipment (except below)	✓	✓	✓	similar	currently	low
	Insulating gas in electrical equipment (high voltage)	✗	-	-	-	-	-
Medical devices	Medical devices (except below)	✗	-	-	-	-	-
	Sterilization gases, propellants for inhalers	✓	✓	✓	-	currently	low
Transport	Other than below (seals, O-rings and gaskets in engines etc)	✗	-	-	-	-	-
	Hydraulic fluids	✗	-	-	-	-	-
	Mobile air conditioning	some	-	-	-	depends	-
	Transport refrigeration	some	-	-	lower	depends	-
Electronics & Semiconductors	Sealing, wire insulation, LCD etc	?	?	-	-	currently	-
	Heat transfer fluids for immersion cooling	✓	?	-	-	-	-
	Photolithography, fluoroelastomers, immersion cooling, plastic flame retardancy	✓	-	-	-	-	-
Energy	Semiconductor manufacturing process	✗	-	-	-	-	-
	Photovoltaic cells, sealing, gaskets, tubes, liners etc	✓	-	-	lower	currently	-
Construction Products	Membrane, reinforcement material	✓	-	✗	lower	2032	-
	Coatings & paints, ETFE film for greenhouses, window frames	✓	✓	✓	-	currently	low
	Membranes (with top coating)	✓	✓	✓	lower	currently	low
	PTFE thread sealing tape	some	some	✓	?	currently	?
	Polymeric PFASs used as processing aids for production of non-PFAS polymers/plastics	✓	✓	✓	-	currently	low
	Surface protection/sealants	✓	✓	✓	lower	currently	low
	Fluorosurfactants as wetting/levelling agents	✓	✓	✓	-	currently	low
Lubricants	Window film manufacturing	?	-	-	-	-	-
	Lubricants in harsh conditions / for safety equipment	✗	-	-	-	-	high
Petroleum and mining	Other lubricants	some	-	-	-	-	high
	Non-polymeric PFAS applications (tracers, anti-foaming agents)	✓	✓	✓	-	currently	low
	Fluoropolymer applications	✗	-	-	-	-	high

Source: UBS based on ECHA PFAS Restriction Proposal Annex XV, European Chemicals Agency, <http://echa.europa.eu/>

Note: Checkmark signifies yes/available, "some" signifies yes/available for some uses, "?" signifies unknown, "X" signifies no/unavailable, and "-" signifies no information.

Sector Impact

The points to note on the US proposal are that 1. the new proposed limits are substantially lower than the previous advisory level, and 2. limits are proposed for 4 types of PFAS other than PFOS and PFOA. The first point is important as these limits make litigation and the need for clean-up/removal more likely and costly. It is also difficult to detect PFAS at very low levels, so there will be a need for testing equipment and services. The second point is especially important for a wide range of companies since the additional 4 types of PFAS are still currently produced and used globally, as opposed to PFOS and PFOA, which have been banned in most developed countries.

The European Chemicals Agency (ECHA) put forward a proposal in February 2023 to restrict the manufacture, use, and sale/import of PFAS or substances/articles containing PFAS above a certain concentration. In essence the proposal is a blanket ban with use-specific 5-year and 12-year derogations. The key questions regarding the ECHA proposal to determine impacts on PFAS-using sectors are: 1. how quickly PFAS alternatives can be developed and at what cost; 2. how many "proposed derogations" or completely new derogations will be included in the final version of the regulation; and 3. whether the derogations could be extended beyond 12 years.

For **companies producing PFAS**, the main concern is not reduced revenue/profit, but significant ongoing litigation and remediation risks. These risks have been well understood in the US and European markets, but have been less of a concern in the rest of the world thus far. See [Figure 21](#) for relative positioning. **Companies producing alternatives to PFAS** such as Tosoh are favourably positioned, but it is still too early to judge which of the current producers of PFAS could benefit given the early stage of development. Among **companies removing and testing for PFAS** such as water utilities and environmental services, the largest companies in the sector are favourably positioned due to the regulatory tailwind for industry consolidation. Water treatment companies and filter manufacturers also stand to benefit. Finally, the largest group of companies to be impacted by tightening PFAS regulation are those **using PFAS in production or in their products**. Potential cost impact is most significant for semiconductors and air-conditioning sectors, but semiconductors might become eligible for a 12-year derogation under the ECHA proposal depending on the result of the public consultation. Apparel, cosmetics, HPC, and food packaging are also impacted but since alternatives to PFAS are readily available, cost impact is generally limited. However, companies that have been early adopters of PFAS-free production are more favourably positioned in terms of future market share growth.

Figure 15: High-level summary of types of base case regulation impact on each sector

		Lower revenue	Higher revenue	Litigation risk	Substitute related costs	Removal cost	M&A tailwind	Awareness & disclosure
Producing PFAS (& substitutes)	Chemicals / multi-industry	✓	(for substitute manufacturers)	✓✓✓	✓	✓✓✓		moderate
	Heating Ventilation and Air Conditioning	✓	(for substitute manufacturers)	✓✓	✓	✓✓✓		low
Test & remove	Water Utilities		✓✓			✓✓	✓✓	-
	Environmental Services		✓✓			✓✓	✓✓	-
Using PFAS	Semiconductors				✓	✓		low at company level
	Electronic Components				✓	✓		low
	Apparel				✓			low outside EU
	Cosmetics			✓	✓			low
	Food & Beverage			✓	✓			low
	Restaurants							low
	Other retail				✓			low

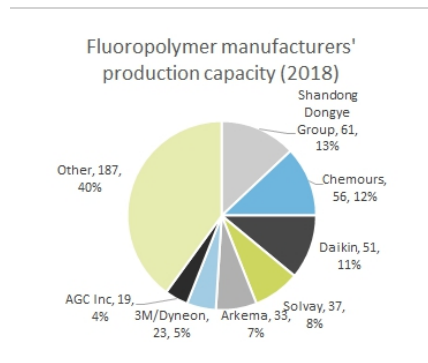
Source: UBS based on Sector Impact pages and ECHA Evidence Review

Note: The number of check marks denote the significance of potential impact to the sector based on contributions from sector analysts and the ECHA Evidence Review.

Companies producing PFAS: The main concern for companies producing PFAS is not reduced revenue/profit, but significant ongoing litigation and remediation risks. These risks have been well understood in the US and European markets, but less understood in the rest of the world thus far. In our base case scenario, we would expect a shrinking market for PFAS starting with the EU, but since the share of PFAS in chemical/HVAC companies' overall sales is limited (1-7% of sales), many PFAS producers (3M, Chemours, Daikin, Arkema, BASF, Clariant and Solvay etc.) are unlikely to face significant impacts in terms of lost revenue/profits. Our 3M coverage team comments that a more challenging regulatory environment has pressured OP margins to ~16% (vs ~26% companywide) so the removal of PFAS should be a modest positive for margins. Daikin's chemicals business OP margin of 17% is significantly higher than its overall business at 9.5%, so PFAS regulations may have a negative impact on overall margins. Margins of PFAS sold to the semiconductor sector appear to be higher than other uses, but since we see semiconductor manufacturing as a sector that is more likely to be given a 12-year derogation in the EU PFAS ban, margin impact would be further down the road.

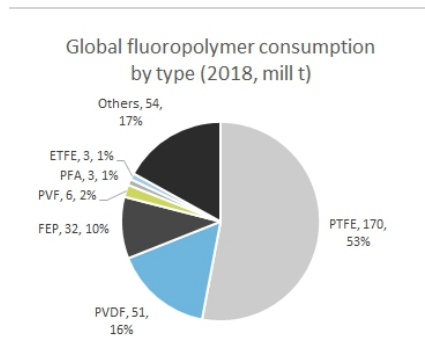
Market share data for PFAS as a group is unavailable, but data exists for fluoropolymer (also known as fluoroplastics) consumption and production capacity as shown below. Fluoropolymers such as PTFAs are used for tubing and gaskets for aviation and automotive applications, membranes and coatings for construction, non-stick coatings for household products, packaging, food processing, and protective clothing among others.

Figure 16: Production capacity for a subgroup of PFAS



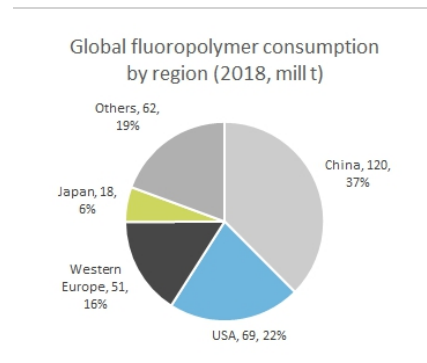
Source: UBS based on AGC website

Figure 17: Consumption by type for a subgroup of PFAS



Source: UBS based on AGC website

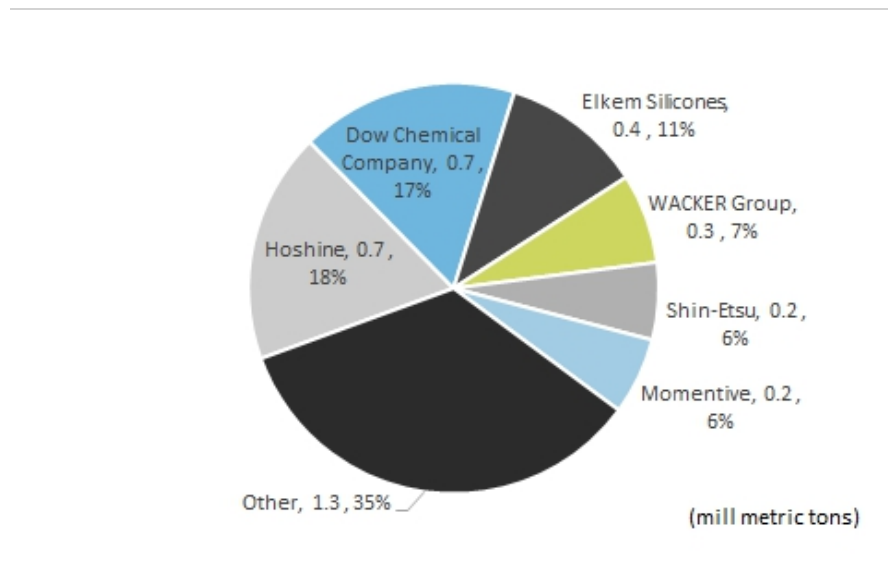
Figure 18: Consumption by region for a subgroup of PFAS



Source: UBS based on AGC website

Companies producing PFAS alternatives: PFAS alternatives range from dendrimers, hydrocarbons, and polyurethanes for textiles, silicones for textiles and cleaners, and ammonia (NH₃), carbon dioxide (CO₂) and hydrocarbons (propane or isobutane) for refrigerants. UBS's Global Chemicals team has identified Tosoh as a supplier of CF₃I, a substitute for SF₆, HPC and Fluoro Ketone used in magnesium casting, and Dow, Wacker Chemie, and Shin-Etsu are suppliers of silicone (see [Figure 19](#) for global capacity). Current PFAS producers are also in a position to develop and supply non-PFAS alternatives to buyers, but it is still too early to judge which of these companies could benefit from increased demand for alternatives given the current stage of R&D. See [Global Chemicals](#) p.24 for examples of early R&D.

Figure 19: Global Silicone Capacity (2022)



Source: UBS based on IHS

Companies removing and testing for PFAS: Water utilities needing to remove PFAS from drinking water face a US\$8.5bn cost of compliance (based on the US EPA proposal, excluding cost of disposal). UBS's Water Utilities team thinks the US EPA regulation will likely increase acquisition opportunities for the largest companies in the sector. UBS's Environmental Services team see increasing regulation as a tailwind for further industry consolidation. PFAS regulation will drive higher landfill and leachate management costs, while also driving higher customer pricing and an opportunity to charge for PFAS management, treatment and disposal. UBS's US Multi-industry team has identified Pentair and AO Smith as providers of commercial and residential water treatment solutions that may stand to benefit. Similarly, the Global Chemicals team has also identified Kuraray as a potential beneficiary given that their subsidiary Calgon Carbon is a supplier of activated carbon (used in the removal of PFAS). Given the monitoring and management requirements in the ECHA proposal, as well as increased scrutiny globally on PFAS levels in drinking water (Canada, UK, Japan etc.), there is clearly an opportunity for PFAS testing services, but UBS does not currently cover companies with significant

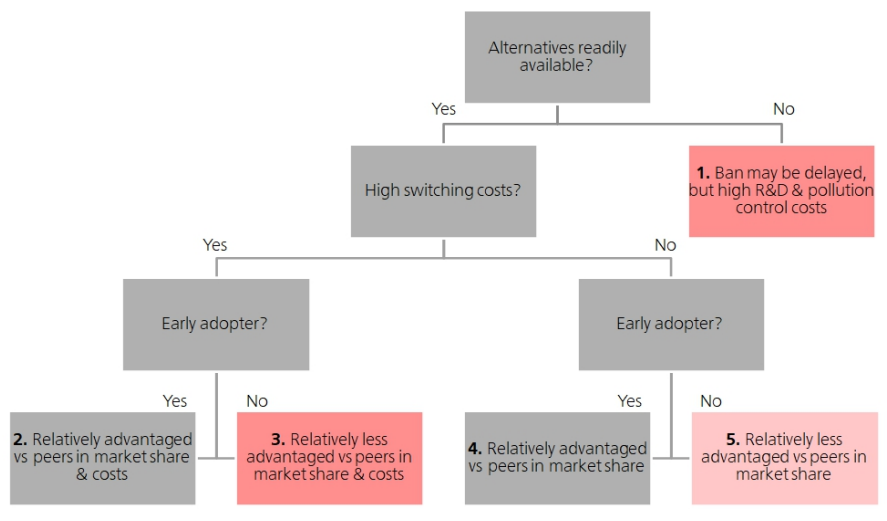
exposure to this business area.

Companies using PFAS: Although the use of PFAS is widespread in many sectors, evidence collected by the ECHA suggests that non-PFAS substitutes exist for most uses. That said, shifting to substitutes may pose significant costs (R&D, testing, process changes, per unit cost) to some sectors and the majority of companies in our coverage have not prepared to shift to non-PFAS alternatives. We think companies using PFAS can be grouped into the following five categories with regard to the impact of a PFAS ban.

1. Alternatives are not readily available, thus the ban may be delayed but high R&D and pollution control costs are expected.
2. Alternatives are readily available, switching costs are high (testing, process changes, unit cost), and the company has been an early adopter of non-PFAS substitutes, so is relatively advantaged versus peers in future market share and costs.
3. Alternatives are readily available, switching costs are high, but the company has not prepared to shift away from PFAS, so is relatively disadvantaged versus peers in future market share and costs.
4. Alternatives are readily available, switching costs are low, and the company has been an early adopter of non-PFAS alternatives, so is relatively advantaged versus peers in future market share.
5. Alternatives are readily available, switching costs are low, but the company has not prepared to shift away from PFAS, so is relatively disadvantaged versus peers in future market share.

In some cases, we also see opportunities for increased revenue if PFAS-free alternatives require more frequent maintenance or replacement.

Figure 20: Impact of a PFAS use ban on companies that use PFAS



Source: UBS

In [Figure 21](#), we summarize the key sector impacts, examples of innovations, as well as most and least favourably exposed companies regarding tightening PFAS regulation looking at the next 5-years.

Figure 21: Sector impact summary

Sector	Region	Exposure	Impact	Innovation	Growth	Margins	ROIC	Valuation	Most favourable	Least favourable
Chemicals	Global	Production/use (c. 1% of sales)	Litigation / Remediation cost (significant tail risk) Loss of PFAS revenue (insignificant) Potential gain in PFAS substitute revenue	Solvay is working on substitutes Perimeter Solutions supplying non-fluorinated fire-fighting foam	→	→	→	→	Kuraray, Tosoh, Wacker Chemie, Dow	Arkema, BASF, Clariant, Solvay, Chemours, Dupont
Multi-Industry	US	Mostly past sale/use of PFAS	Litigation / Remediation cost (significant risk – \$31B) Loss of PFAS revenue (insignificant at 3-4%) Overall margin improvement Potential gain in PFAS substitute revenue	3M to exit PFAS market	→	→	→	→	Pentair, AO Smith	3M
Heating Ventilation and Air Conditioning	Global	Production/use (chemical biz 7% of sales)	Loss of PFAS revenue Litigation / Remediation cost HFC refrigerant not subject to PFAS regulations	PFAS collection rate (currently 99%; target 99.9%); med.-term plan to expand portfolio to non-PFAS substances.	→	→	→	→		Daikin Industries
Water Utilities	US	Potentially affects all water supply	Removal compliance cost (EPA proposal implies \$8.5B) Increased acquisition opportunities	AWK is piloting ion exchange resins & granular activated carbon	→	→	→	→	American Water Essential Utilities	Public Water Systems
Environmental Services	North America	Removal tech/services less than 5% of sales	Higher landfill & leachate management costs Tailwind for industry consolidation Potentially higher pricing	CLH studied high-temp thermal destruction	→	→	→	→	Clean Harbors, Waste Management, Republic Services	OPAL
Semiconductors / Tech Hardware	Global	Current use (c. 50-100% of sales)	Lower margins, ROIC, and potentially valuation	Industry body estimates that substitution could take 3 to 20+ years	→	→	→	→		Across the industry
	Japan	Current use (c. 20-100% of sales)	Higher R&D cost of developing substitutes Potential fines if non-compliant		→	→	→	→		Renesas, Sony, Tokyo Electron
Electronic Components	Japan	No disclosure (likely used widely)	Higher R&D cost to find substitutes Potentially negative impact on margins and ROIC	Limited disclosure on PFAS, and many companies are still investigating the issue	→	→	→	→		Rohm, Ibiden, Shinko Electric
Softlines	US	Current use	Mild pressure on short-term margins Market share opportunities for early adopters	LEVI already banned and eliminated PFAS from supply chain	→	→	→	→	Deckers, Levi's, Signet Jewelers	Macy's, Nordstrom, Kohl's
Apparel	Europe	Past use only	No material direct impact given early adoption of PFAS alternatives	Most brands already banned PFAS use	→	→	→	→	Inditex, Zalando, AboutYou	
Retail	Japan	Current use	No material impacts since substitutes are available (some COGS increase, relative market share loss is possible)	Fast Retailing is committed to PFAS elimination	→	→	→	→	Fast Retailing	
Cosmetics	Korea	Current use (approx. 1% of sales)	No material impacts due to limited exposure and focus on skin-care	Amorepacific already bans or restricts PFAS	→	→	→	→	Amorepacific, LG H&H	
	Japan	Current use	One-time increase to costs due to reformulation Market share opportunities for early adopters	Shiseido is developing PFAS-free products with similar functionality.	→	→	→	→	Shiseido, Kose	
	China	Current use (approx. 1.5% of sales)	No material impacts unless specific regulation for cosmetics is implemented in China, or no significant shift in consumer mindset	Minimal discussion of PFAS currently	→	→	→	→	Botanee, Proya, Bloomage	
Household & Personal Care / Beverages	US	Current use (insignificant as a % of sales)	No material impacts across coverage Some potential for litigation risk in HPC Some potential for higher costs due to changes to manufacturing process	YETI removed long-chain PFAS from all products	→	→	→	→	Yeti, beverage companies	Estee Lauder, Procter & Gamble
Restaurants	US	Current use (insignificant as a % of sales)	No material impacts due to low exposure	QSR restaurants such as RBL, YUM, and MCD aim to eliminate PFAS by '25	→	→	→	→	The Cheesecake Factory, Bloomin' Brands, Texas Roadhouse	Restaurant Brands International, Yum! Brands, McDonald's
Packaged Food	US	Current use (insignificant as a % of COGS)	No material impact since substitutes are available (a matter of changing sourcing) Brand perception improvement for early adopters	-	→	→	→	→	Nomad Foods, Mondelez International	The Hershey Company, Conagra Brands
Food & Beverage	China	Current limited use	No material impact unless PFAS bans are expanded beyond Stockholm 3 within China	Yili and Mengniu restrict use of Stockholm 3	→	→	→	→	Yili, Mengniu	

Source: UBS

This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Tail Risks: Although the following tail risks are not our base case, they are not so far fetched either. For example, the US EPA published its "PFAS Strategic Roadmap" in October 2021, which includes the objectives "Use and harmonize actions under all available statutory authorities to control and prevent PFAS contamination and minimize exposure to PFAS during consumer and industrial uses," and "Establish voluntary programs to reduce PFAS use and release."

- PFAS producers - litigation
- PFAS users - sudden boycotts or litigation (see [PFAS Litigation](#) for examples)
- all related sectors - sudden or extremely strict regulations (e.g. PFAS ban in the US, no derogation for semiconductors in the EU).

UBS Research THESIS MAP

Global Chemicals

EXPOSURE

Production and use of PFAS chemicals: Approx. 1% of sales

IMPACT ON SECTOR

Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

PFAS regulation and associated legal and environmental costs of previous production footprints have been at the top of investors' minds since the back half of the last decade. As we move towards some greater regulation, however, companies will have to replace these chemicals in a wide range of areas such as cookware, cosmetics, firefighting foams & electrical components. By mid-decade EU-based producers will have to phase out production albeit the exact timetables & full extent are not clear at this stage. Tightening water standards (ie US EPA) will likely increase ongoing remediation costs for exposures at certain sites, and for any existing current users result in tighter emissions controls, perhaps requiring further investments.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

Yes; the industry, partly driven by a voluntary decarbonisation agenda, and partly driven by regulatory necessity, is seeking to find alternative technologies. Many companies have formulated away PFAS materials of most concern over a decade ago (e.g. PFOA), but other PFAS materials remain in use. Areas of research and development range from bio-based materials (from sugars and plant oils) to materials science / nanotechnologies using inorganic products (eg using tio2 and siloxanes). Some companies are also exploring petrochemicals-based alternatives, which include polyurethane and polyester-based technologies. As specific examples, Solvay is working on a new polymerization process which is non-fluorosurfactant, and Perimeter Solutions has increasing sales of non-fluorinated firefighting foams. Tosoh is a supplier of CF3I, a substitute for PFAS used in magnesium casting. For some current high end use cases for PFAS materials (e.g. semis, membranes), it is not clear there is currently an effective substitute for those industrials. Several companies also provide technologies for PFAS removal. Asahi Kasei supplies removal technologies for fluorine in water. The technology is described as reducing fluorine levels in water to 0.8mg per liter. Kuraray produces activated carbon, which can be used to remove PFAS.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5 years?**

The tail risk is related to both accelerated environmental and legal timetables and the deterioration of ROCE and cash flows as a consequence of remediation work to water systems and/or unsuccessful legal defences. As we reported [here](#), Chemours, Dupont, and Corteva reached an agreement with US Water Systems on June 2, 2023 regarding the majority of PFAS-related drinking water claims in the US for US\$1.185bn. This was at the low end range of market expectations. Some cities and towns with the strongest cases are more likely to hold out, and can increase these costs further. See [PFAS Litigation](#) on p65 for details.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

In EU Chemicals Arkema, BASF, Clariant and Solvay are currently all named in several PFAS/PFOA legal actions in the US. Arkema and Solvay (and BASF and Clariant) did not produce PFAS/PFOAs, unlike US peers Chemours and 3M, but used them as raw materials during their production processes. Chemours (CC) has the most acute risk, with ~20% of sales fluoropolymers (not producing/selling PFOS/PFOA), which fall into PFAS family chemistry. 3M has indicated its intent to exit the market, while Chemours has focused on higher value/growth markets (deselecting from consumer, more at risk industries). However, outright bans with no separation of risk/benefit could impact its broader portfolio. Among Japanese companies, Asahi Kasei and AGC entities in the US have also been named in legal actions, but much less frequently than the major US players.

MOST FAVOURABLY
EXPOSED

Company	Comment
Kuraray	Subsidiary Calgon Carbon is a supplier of activated carbon used in removal of PFAS
Tosoh	Supplier of CF3I, a substitute for SF6, HPC and Fluoro ketone for magnesium casting

Wacker Chemie	Supplier of silicone for medical, textile, personal care, electronics, and transport uses
Dow	Supplier of silicone for building, consumer goods/appliances, tape, paint, textile uses

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURABLY EXPOSED

Company	Comment
Arkema	Exposed to litigation risk; previous owner Total may share costs in negative outcome.
BASF	Defending itself against 2,200 lawsuits as of Jan 2023.
Clariant	Exposed to litigation.
Solvay	Exposed to litigation, taking a €93m provision for remediation work.
Chemours	Exposed to litigation risks and material sales risks in a scenario of outright PFAS ban.
DuPont	Capped liability risk (residual owned by Chemours), minor sales/materials risk.

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

PAST EXAMPLES

Q: What past events/themes would you draw parallels to?

Typically the sector has been adept at moving to new technologies, with examples across pesticides. However we should also be cognisant of the more significant impacts of outsized litigation fines, for example the impact of glyphosate litigation on Bayer.

Geoff Haire	██████████@ubs.com	██████████
Joshua Spector	██████████@ubs.com	██████████
Charles Eden	██████████@ubs.com	██████████
Amily Guo	██████████@ubs.com	██████████
Shunta Omura	██████████@ubs.com	██████████

UBS Research THESIS MAP

US Multi-Industry

EXPOSURE

PFAS-related revenues are increasingly irrelevant for our coverage (share of sales for 3M: 3-4%). Litigation resulting from past sale/use of PFAS is far more important.

IMPACT ON SECTOR

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

3M plans to wind down its manufacture and use of PFAS by the end of 2025. 3M's ca. US\$1.3bn in annual revenue from PFAS represents 3-4% of total revenues, however a more challenging regulatory environment has pressured op. margins to ~16% (vs ~26% companywide) so the removal of PFAS should be a modest positive for margins. That said, the company will likely continue to face litigation for years to come due to its past use of PFAS chemicals, which should have a far larger impact on cash flows and valuation than the loss of PFAS revenues.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

Innovation will likely not be an important factor related to PFAS as evidenced by 3M's plan to phase out PFAS production by year-end 2025. We think this decision reflects an increasingly stringent regulatory environment that in practice could make any presence of PFAS in water an ongoing issue for 3M and others.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5-years?**

It will be difficult to predict the timing of lawsuits but over the coming years we expect legal fees & charges to continue with potentially large cash settlements related to PFAS clean-up, medical monitoring, and/or personal injury. 3M has ca. US\$0.6bn in other environmental liabilities, in our view understating the potential costs which we estimate to be US\$31bn--all of which we assign to 3M in our price target calculation. Our estimates are based on conversations with experts, the US PFAS Water Contamination Tracker, and analysis of prior settlements ([link](#)). In early June 2023, we [reported](#) on 3M's US\$10bn+ tentative settlement with a host of US cities and towns, separate settlements with Rome, Georgia (US\$100mn) and progress towards a settlement with Stuart, Florida. We see ongoing progress and mediation as a positive for 3M as it provides some visibility and could allow the overhang to be lifted quicker than previously thought.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

3M is least favourably exposed. While other companies / subsidiaries of companies in our coverage (CARR, JCI, HON) have been named in lawsuits related to PFAS chemicals, we believe the vast majority of liability would fall on 3M, and based on our conversations with legal & technical experts the government contractor defense⁵ is least likely to apply to 3M. Pentair (PNR) and AO Smith (AOS) provide residential and commercial water treatment solutions, and hence should be beneficiaries of rising consumer awareness and focus on water quality as a result of regulatory review of PFAS. That said, should wider scale removal of PFAS from public water occur at the municipal level, it could limit the need for homeowners and businesses to purchase their own filtration products/systems.

MOST FAVOURABLY
EXPOSED

Company	Comment
Pentair	Provider of commercial and residential water treatment solutions
AO Smith	Provider of commercial and residential water treatment solutions

⁵. Used to protect the interests of the federal government by giving private contractors (e.g. chemical manufacturers) liability protections for manufacturing products for the government (e.g. for the military).

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURABLY
EXPOSED

Company	Comment
3M	PFAS-related revenues are increasingly irrelevant, but litigation risks remain important.

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Chris Snyder	██████████@ubs.com	██████████
Neal Burk	██████████@ubs.com	██████████
Damian Karas	██████████@ubs.com	██████████

UBS Research THESIS MAP

UBS Research THESIS MAP

Global Heating Ventilation and Air Conditioning (HVAC)

EXPOSURE

Production and use of PFAS chemicals: Overall chemical business approx. 7% of sales for Daikin.

IMPACT ON SECTOR

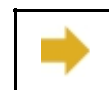
Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

PFAS are used to produce fluorinated gases, which are used in refrigeration, air-conditioning, and heat-pumps. A major fluorinated chemical and air conditioner manufacturer, Daikin Industries, is enhancing PFAS collection rates as an environmental measure. The collection rate is 99.0% at present and the company is aiming to raise the rate further to 99.9% by 2025. Daikin uses many types of refrigerants in its air-conditioners. Note that one of Daikin's key refrigerants, R-32 (CH₂F₂), is excluded from the EU and OECD definition of PFAS, while R-410A, R-134A, and 454B are included.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

The ECHA's evidence review suggests that PFAS use for air-conditioning and heat-pumps may be continued in cases where building regulations and fire codes do not allow for use of alternatives such as hydrocarbon refrigerants, CO₂, and ammonia. c.91% of Daikin's business is related to the refrigerant R-32(CH₂F₂), a greenhouse gas which contains a F-C bond, but is not considered persistent because it has an atmospheric lifetime of only 5.4 years and degrades into CO₂ and HF (not a PFAS arrowhead). Daikin has not disclosed information on how its chemicals business will be impacted by or will respond to the ECHA proposal. Currently, the company's information disclosure is limited, except that it is avoiding outflows from its factories as much as possible, and that it aims to expand its chemicals offering to non-fluorine materials as well (e.g. silicone, next gen materials for semiconductors, biomass based materials).

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5-years?**

Daikin's chemical business accounted for 7% of sales and 12% of OP in FY3/23. The chemical business OP margin of 17% is significantly higher than its overall business at 9.5%. Its medium-term plan targets chemicals OP growing by 21% by FY3/26 (OP margin 18%). Daikin's regional chemicals sales exposure is highest in Japan (27%), followed by the Americas (23%), then China (21%), and Europe (16%). The direct impact on Daikin of a PFAS ban would be refrigerant development/replacement cost and a reduced market for its chemicals business. Given Daikin's high exposure to the US market, litigation and remediation risks based on past production cannot be ruled out even though the current plant PFAS collection rate is 99.0% (the company has been named as a defendant in [Michigan](#), [Georgia](#), and [Ohio](#)). The end-client industries for Daikin's chemical business include semiconductors, automobiles, IT & handsets, renewable energy, and air conditioners. Any major air conditioner refrigerant manufacturers that use PFAS are likely to be required to accelerate replacement and development of next-generation refrigerants.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

As we mentioned above, Daikin Industries is likely to be heavily affected in the global HVAC sector. On the other hand, the air conditioner market is likely to continue to grow over the medium term regardless of the PFAS regulations. Accordingly, the companies that develop more economically rational and useful next-generation refrigerants that do not have a greenhouse gas effect earlier than peers are expected to become even more competitive in the market.

LEAST FAVOURABLY
EXPOSED

Company	Comment
Daikin Industries	One of the leading fluorine chemical suppliers. One of Daikin's key A/C refrigerants is not included in the PFAS definition used by the OECD and EU, while others are included.

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Hikaru Mizuno

██████████@ubs.com



UBS Research THESIS MAP

US Water Utilities

EXPOSURE

Management of PFAS levels in water. Potentially affects all water supply.

IMPACT ON SECTOR

Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

Companies will complete testing over the next 1-2 years in anticipation of a compliance deadline by 2027 from the US Environmental Protection Agency's proposed rule. Rate cases or tracking mechanisms would recover the costs for investor owned utilities. The regulation will likely increase acquisition opportunities for the largest companies in the sector.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

Yes. American Water Works (AWK) and Essential Utilities (WTRG) have identified investments in PFAS compliance technology. AWK is piloting ion exchange resins along side granular activated carbon to compare PFAS removal and media performance. AWK has installed GAC to remove PFAS at five locations that have elevated source water levels.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5 years?**

Based on the EPA proposal water systems face an US\$8.5bn cost of compliance. This excludes costs of co-occurrence of PFAS with other contaminants and the cost of disposing of spent filtration materials. EPA estimated that the per person cost to comply at larger systems (greater than 3,300 people to 10,000 people) for granular activated carbon is US\$136-US\$239, for ion exchange US\$121-US\$218 and for reverse osmosis US\$326-US\$462. The penalty for non-compliance falls under the Section 1433 of the Safe Drinking Water Act, up to US\$27,500/day per occurrence.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

AWK and WTRG could experience an increase in their acquisition contribution to EPS growth. AWK's 8% EPS growth rate includes 1% to 2% from acquisitions.

MOST FAVOURABLY
EXPOSED

Company	Comment
American Water	2023 environmental budget: US\$195mn. PFAS compliance spending disclosed: US\$1bn in capex and US\$50mn in operating expenditure over the next 3-5 years.
Essential Utilities	2023 PFAS related budget: US\$40mn. Has company PFAS control targets. (Guidance on 2Q'23 results call)

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURABLY
EXPOSED

Company	Comment
Public Water Systems	3,400-3,600 water systems expected to be non-compliant according to US EPA.

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

MILESTONES

Q: What milestones are we watching in US regulation?

Completion of the EPA proposed rule. We expect a ruling as early as 3Q'23 but by early 2024.

Gregg Orrill	 @ubs.com	+ 
Ross Fowler	 @ubs.com	+ 

UBS Research THESIS MAP

UBS Research THESIS MAP

North America Environmental Services

EXPOSURE

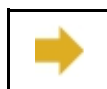
Removal tech/services; less than 5% of sales

IMPACT ON SECTOR

Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

PFAS remediation is an opportunity for the North America Environmental Services sector. In our view, increasing regulation is likely to drive a tailwind for further industry consolidation in the medium term with smaller, less well capitalised companies potentially opting to sell to avoid compliance costs.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

Clean Harbors (CLH) recently completed an environmental study for PFAS elimination through high-temperature thermal destruction. The 2021 study demonstrated 99.9999% PFAS elimination and stack emissions that were well below federal ambient air limits. The company is in dialogue with regulators to position its network of hazardous waste incineration capacity.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5-years?**

In 2022, the US EPA proposed designating two PFAS compounds as hazardous substances. PFAS compliance will likely drive higher landfill and leachate management expenses for the industry. However, the consolidated nature of US landfill capacity will likely drive higher customer pricing and an opportunity for the waste companies to charge for PFAS management, treatment, and disposal services.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

Within our coverage, we see Clean Harbors Inc (CLH), Waste Management Inc (WM), and Republic Services Inc (RSG) as well positioned to benefit from new compliance rules given their existing hazardous waste treatment & disposal assets.

MOST FAVOURABLY
EXPOSED

Company	Comment
Clean Harbors Inc	Existing network of hazardous waste incineration.
Waste Management Inc	Existing network of hazardous waste treatment and disposal.
Republic Services Inc	Existing network of hazardous waste treatment and disposal.

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURABLY
EXPOSED

Company	Comment
OPAL Inc	PFAS compliance cost potentially crowding out some incremental renewable natural gas investment.

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

PAST EXAMPLES

Q: How have environmental regulations impacted the sector in the past?

Historically, environmental regulation and higher compliance thresholds create cost and complexity in the waste industry, which has enabled consolidation and limited competition from the long tail of waste services companies.

Jon Windham
William Grippin

██████████@ubs.com
██████████@ubs.com



UBS Research THESIS MAP

UBS Research THESIS MAP

Global Semiconductors

EXPOSURE

Current/Past use. Approx. 50 - 100% of sales.

IMPACT ON SECTOR

Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

PFAS play a critical role at several stages in the manufacturing process of a semiconductor, from lithography to packaging, so substitution will be the likely path that companies follow. However, in many cases the materials that currently contain PFAS have such unique and specific technical requirements that substitution will be challenging. Not only does a substitute need to be found, developed and readied for high volume manufacturing (HVM) but the change may require additional tooling or process changes that will further lengthen timelines for implementation of alternatives. In a report commissioned by the Semiconductor Industry Association (SIA), RINA Tech estimate that timelines for substitution could stretch from 3 years to beyond 20 years, if a viable alternative is even achievable. In the short term companies are likely to push for exemptions (seen [recently](#)) to any bans given the criticality of semiconductor supplies to the wider global economy, as exhibited during the COVID-pandemic related supply disruption.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

Many companies in the sector have joined SIA's Semiconductor PFAS Consortium, which is a group formed to formulate an industry-wide approach and better inform public policy and legislation related to the semiconductor industry's use of PFAS. Members include 10 device manufacturers, 8 equipment suppliers and 21 chemical/ material suppliers. In terms of the device manufacturers and equipment suppliers, they scarcely mention PFAS directly, beyond flagging them as a potential regulatory risk to the business.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5 years?**

If bans are phased in, it is likely to have a negative impact on margins, ROIC and potentially valuation. There would be an associated R&D cost of finding and developing alternatives, potentially higher capex if investments are needed to adjust processes and machinery, potentially higher cost of alternatives and potential fines for not complying with new regulations. It is likely that some of these costs would be passed on to customers through higher prices.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

The impact is likely to be felt across the industry, whether directly through higher costs or indirectly through higher prices. Foundries, OSATs and IDMs are likely to be the most directly impacted, given their position in the manufacturing process exposes them to the point of use of PFAS. Equipment suppliers will be impacted by any changes to the manufacturing process necessitated by PFAS substitutes, while fabless companies would likely be impacted through higher prices.

Francois Bouvignies

Harry Blaiklock

[REDACTED]@ubs.com

[REDACTED]@ubs.com

[REDACTED]

[REDACTED]

UBS Research THESIS MAP

Japan Tech Hardware

EXPOSURE

Current/Past use (Approx 20-100% of sales)

IMPACT ON SECTOR

Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

Semiconductor related players would be negatively impacted due to usage of PFAS in the semiconductor manufacturing process, from lithography to packaging, most intensively in the dry etching process. The restriction requires additional cost for semiconductor players, semiconductor users and equipment vendors. One of the heaviest usages of PFAS occurs in the dry etching process, where PFAS is used to keep surface temperatures on wafers during process. The control of temperature is critical as it directly relates to process quality.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

Many companies in the sector have joined SIA's Semiconductor PFAS Consortium, which is a group formed to formulate an industry-wide approach and better inform public policy and legislation related to the semiconductor industry's use of PFAS.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5 years?**

If bans are phased in, it is likely to have a negative impact on margins, ROIC and potentially valuation. There would be an associated R&D cost of finding and developing alternatives, potentially at a higher cost than currently. It is likely that some of these costs would be passed on to customers such as tech conglomerates that produce infrastructure equipment.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

The negative impact would be felt by semiconductor players first, and next would be customers such as tech conglomerates that buy semis at a higher price. Incremental R&D costs would be incurred by semi equipment vendors. We see no winners from tightening PFAS regulation in this sector.

LEAST FAVOURABLY
EXPOSED

Company	Comment
Renesas	One of the biggest semiconductor firms in Japan (100% of its revenue is semiconductors).
Sony	A big CMOS sensor player in the global market, but the division is 20% at the corporate level.
Tokyo Electron	One of the biggest suppliers in dry etching so probably needs to spend more on R&D.

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Kenji Yasui

kenji.yasui @ubs.com

Sean Park

[REDACTED]@ubs.com

UBS Research THESIS MAP

UBS Research THESIS MAP

Japan Electronic Components

EXPOSURE

Likely being used in a wide range of electronic components (no disclosure)

IMPACT ON SECTOR

Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

As products handled by electronic component companies vary by company, exposure to PFAS also differs from company to company. Many avoid detailed disclosure, making it difficult for us to ascertain all the facts, but PFAS appear to be used in making a wide range of electronic components in electrical equipment, such as refrigerants for power semiconductor production, insulation cases, sealing materials, and lead cable films for components. If regulation is tightened, companies are likely to consider substitutes, but if they find it difficult to find substitutes, they may ask the authorities for a moratorium or exemption from regulations via industry organisations or others.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

In our interviews with industry companies, we received answers from some that they do not use PFOS or PFOA, which are currently subject to European REACH regulations. Given the large number of substances on the PFAS list, however, many of the companies simply answered that they are currently investigating, or that they choose not to disclose details. These companies are likely to cope with regulation by considering substitutes or, if that is impractical, to plead with authorities for moratoria or exemptions.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5 years?**

If the scope of the PFAS regulations is widened, companies will be required to switch to substitute materials. In order to do so, they will have to spend more on R&D. It is difficult to estimate the scale of impact given limited disclosures, but we expect changes to depress profit margins and ROIC.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

In the tech hardware sector, the semiconductor industry, which uses PFAS in processes ranging from lithography to packaging, is most exposed to the scenario. In our coverage, power semiconductor companies and package substrate manufacturers are likely to be affected significantly. It is difficult at this stage to predict which companies will benefit from tightened regulations, but those that can respond flexibly to regulation may expand market share, mainly among European clients. Depending on how companies cope with regulations, disparities among them may widen.

LEAST FAVOURABLY
EXPOSED

Company	Comment
Rohm	Major manufacturer of analogue and power semiconductors. Some 90% of sales are generated by semiconductors, about 7% in Europe
Ibiden	Major manufacturer of semiconductor package substrates; about 50%-60% of sales are estimated to be generated by package substrates, about 8% in Europe
Shinko Electric	About 65% of sales are generated by IC package substrates; exposure to Europe is roughly zero.

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analyst base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Shingo Hirata

@ubs.com

US Softlines

EXPOSURE

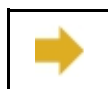
Approx 60% of sales of our coverage universe based on apparel sales.

IMPACT ON SECTOR

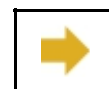
Growth:



Margins:



ROIC:



Valuation:



SECTOR IMPACT (REGULATION)

Q: How are the companies likely to respond to tightening PFAS regulation?

Most US companies have developed their own guidelines on usage of chemicals or follow a national association's guidelines. We therefore believe companies will invest in processes to gradually phase out the use of PFAS across all products if US regulation on PFAS tightens. In fact, many companies in our coverage universe have either already established targets to eventually stop using PFAS in their product lines or eliminated PFAS from their supply chain.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

Yes. Softline companies are looking for substitutes to comply with PFAS regulation, while preserving the key attributes provided by these substances, such as water repellence. For instance, LEVI has banned the use of PFAS in its products and already eliminated these chemicals from its supply chain.

SECTOR IMPACT (FINANCIAL)

Q: What will be the likely financial impact on the industry in the next 5-years?

We think initial investments to improve manufacturing processes could mildly pressure short-term margins and returns, but do not believe these will have a material effect on long-term metrics. At the same time, we see potential market share opportunities for ESG-focused companies that stand out for being early adopters. Consumers are increasingly paying attention to ESG matters, particularly Gen Z consumers, and will likely favour brands and retailers with an environmental focus. We therefore think these companies' growth would outperform.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

Overall, we believe companies with strong balance sheets will have the financial flexibility to invest and transition more rapidly than those with financial constraints. We think Levi's (LEVI) and Deckers (DECK) will be among the most favoured names given a high ESG-focus and early elimination of PFAS from their supply chains. Since PFAS regulation is most related to apparel, we believe companies with a higher skew towards footwear and accessories categories will be relatively less impacted by this issue. Some companies we believe fall under this criteria include Signet Jewelers (SIG) and On Holding (ONON). At the same time, we underscore several companies where we have a bearish view on their fundamentals and lack a clear timeline to phase out all types of PFAS. These include Macy's, Kohl's, and Nordstrom.

MOST FAVOURABLY EXPOSED

Company	Comment
Deckers	High exposure to footwear and already phased out PFAS usage.
Levi's	High ESG focus and already stopped making products with PFAS.
Signet Jewelers	No exposure to apparel as 100% of sales comes from jewelry.

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURABLY EXPOSED

Company	Comment
Macy's	No clear commitment on PFAS elimination timeline.
Nordstrom	No clear commitment on PFAS elimination timeline.
Kohl's	Limited restriction of PFAS usage on its supply chain.

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Jay Sole	[REDACTED]@ubs.com	[REDACTED]
Mauricio Serna	[REDACTED]@ubs.com	[REDACTED]
Tiffany Agard	[REDACTED]@ubs.com	[REDACTED]
Natalie Koltermann	[REDACTED]@ubs.com	[REDACTED]

UBS Research THESIS MAP

UBS Research THESIS MAP

European Apparel Retail

EXPOSURE

Past use only

IMPACT ON SECTOR

Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

European apparel/fashion retailers have banned the intentional use of PFAS. With water use being an important step in production for dyeing/washing, etc. the garments may however still be exposed to PFAS if the water source itself may be contaminated with traces of PFAS. Given that retailers generally rely on the supply chains in Asia, the companies have undertaken control measures such as regular proficiency tests for substances including PFOS, PFOA, PFHxA, PFHxS and related salts. Companies have strictly outlined in their chemical management policies not to merchandise garments containing PFAS above certain thresholds.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

Players such as H&M (HMB), Inditex (ITX), Zalando (ZAL), Asos (ASC), Next (NXT) among others have come together to become signatories/contributors of the Zero Discharge of Hazardous Chemicals Program (ZDHC). The ZDHC creates a 'Manufactured Restricted Substances List' or MRSL which lays out the maximum thresholds for PFAS and other hazardous substances. The main goal of the ZDHC is to certify players in the value chain based on garment testing and thresholds so that players sourcing from ZDHC certified suppliers may be assured that garments are in adherence to the PFAS regulation. There is limited disclosure on innovation with respect to substitutes for PFAS.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5 years?**

We do not see material near-term/medium-term direct financial impact specifically from PFAS given most players have already banned intentional use in adherence to regulation. That said, companies may potentially step up their testing intensity for PFAS, which may not be a meaningful direct cost but lengthen the lead time taken from on-site production to merchandising, which may have an indirect financial impact due to higher fashion risk. This would also eliminate the risks in the supply chain over time of unintentional/indirect usage as we point to below.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

In our view ITX is the most favourably positioned given its proximity sourcing strategy. Given ITX sources 60-70% from suppliers in and close proximity to Europe, more of their suppliers (especially those in the EU) are likely complying with any anticipated EU requirements on PFAS and the water quality thresholds. Marketplaces selling partner brands like AboutYou (YOU) and ZAL may see little or no impact as the partner brands would bear the quality and testing responsibilities. It is difficult to have a view on least favourably positioned stocks given the apparel industry's own efforts to identify and eliminate direct 'intentional' usage of PFAS as explained above. We are also seeing countries in the supply chain outside Europe (for example China) banning the production and use of PFOA and PFOS. Exposure from less well-regulated supply chains than EU supply chain standards could potentially increase the risk; however, this may be different even on an individual supplier basis, which may be difficult to detect and map.

MOST FAVOURABLY
EXPOSED

Company	Comment
Inditex	Proximity sourcing strategy with EU based suppliers likely complying with PFAS/water quality requirements.
Zalando	Selling partner brands with limited own brand exposure.
AboutYou	

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Sreedhar Mahamkali	██████████@ubs.com	██████████
Yashraj Rajani	██████████@ubs.com	██████████

UBS Research THESIS MAP

UBS Research THESIS MAP

Japan Retail

EXPOSURE

Likely used for water-repellent apparel and food packaging (no disclosure)

IMPACT ON SECTOR

Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

If PFAS regulations are introduced or tightened, Japanese retail companies may be required to cope with 1) indirect risk from sustainability of merchandise procurement and COGS increases, and 2) direct impacts from review of materials and managing supply chains for products developed in-house, including PB (private brand) products.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

Environmental awareness has grown in recent years in Japan's retail sector as a whole, but companies do not appear to have made much progress toward serious discussions or making adequate preparations for PFAS regulation. Since Europe and the US are ahead of Japan in terms of regulations and action, we assume Japanese retail companies that are active overseas, including in Europe and the US, are ahead of their peers in PFAS-related measures.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5 years?**

Since retailers generally handle a wide variety of merchandise, it should be comparatively less difficult for them to find substitutes. Therefore, we do not anticipate a serious impact on earnings. Still, we assume there is a risk of higher COGS alongside the shift to substitutes, and that they have a relatively high risk of losing customers if differences in domestic and overseas regulations cause infringements, or if they do not mount an adequate response, particularly in the case of in-house-developed PB products.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

In Japan's retail sector, Fast Retailing (9983), which operates globally, is ahead of its peers in terms of response to PFAS regulations. We therefore think it is positioned relatively well. The company made a commitment in 2013 to fully eliminating discharge of hazardous chemical substances and disclosed guidelines for partner manufacturers and a list of the substances subject to its rules. Also, in order to contribute to the resolution of issues that affect the entire sector, the company has joined the Zero Discharge of Hazardous Chemicals (ZDHC) group, consisting of major European and US brands. It is the only Japanese company belonging to the ZHDC. Nitori (9843) and Ryohin Keikaku (7453), which manufacture their own merchandise, as Fast Retailing does, monitor factories and manage supply chains in ways that require subcontracted producers to monitor and reduce the use of chemical substances. At present, however, they have not joined any international group such as ZHDC.

MOST FAVOURABLY
EXPOSED

Company	Comment
Fast Retailing (9983)	Leading Japan's retail sector in PFAS measures as a global brand

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analyst base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Nozomi Moriya

Yusuke Isogai

Xuening Wen

██████████@ubs.com

██████████@ubs.com

██████████@ubs.com

██████████

██████████

██████████

UBS Research THESIS MAP

Korea Cosmetics

EXPOSURE

Current/Past use: Approx. less than 1 % of sales.

IMPACT ON SECTOR

Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

There have been no PFAS regulations implemented yet for Korea cosmetics firms. However, according to major Korea cosmetics players, they have been trying to reduce exposure to PFAS considering customers' concerns about human and environmental safety. Accordingly, they have established and applied their own global-leading quality standards for using ingredients. However, small to medium-sized cosmetics firms have not closely monitored PFAS regulation yet, while the Ministry of Food and Drug Safety has been trying to closely monitor Korean cosmetics firms' PFAS usage.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

According to Amorepacific management, it restricts the use of PFAS in raw materials and products given the problem of accumulation in the environment or living organisms has been an issue due to the hard-to-decompose characteristics. Even if certain ingredients can be used legally, Amorepacific manages them as prohibited or restricted according to Amorepacific's internal criteria relating to safety assessment studies. LG H&H has also been trying to reduce PFAS in its raw materials and products, but does not provide a timeline towards elimination.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5 years?**

We expect limited financial impact for Korean major cosmetics players considering 1) limited exposure to PFAS, 2) their focus on the skincare category rather than the makeup category, which uses more PFAS as an ingredient. If regulations are implemented, we think it could have a negative impact for mass brands, which have focused on the makeup category.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

We think there should be limited impact on the Korea cosmetics sector overall, while Amorepacific / LG H&H should partially benefit if tightening regulations are implemented as 1) Amorepacific already prohibited using PFAS in its products / raw materials and 2) both Amorepacific and LG H&H have been focusing on the skincare category.

MOST FAVOURABLY
EXPOSED

Company	Comment
Amorepacific	Focus on premium skincare category; already restrict using PFAS.
LG H&H	Leading domestic skincare / household / beverage company; trying to reduce PFAS exposure.

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Jaehyung Choi

██████████@ubs.com

+ 82-2-3702 8172

Jiwoo Hong

██████████@ubs.com

+ 82-2-3702 8807

UBS Research THESIS MAP

Japan Cosmetics

EXPOSURE

Current/Past use (no disclosure on exposure)

IMPACT ON SECTOR

Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

In the cosmetics sector, regulations are already moving forward in overseas markets. Laws have been established in California, and interest is surging in the EU, Australia, New Zealand, and Asia. Japan is not yet considering PFAS regulations as broad as those in Europe and the US, and there has so far been no material impact on business. Shiseido has already eliminated many PFAS substances, and is taking action to eliminate substances in the broader definition of the PFAS. Kose may make adjustments to comply with these regulations in the development process of products that use PFAS, but there will be no impact on the final product.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

Shiseido is preparing for development of products without PFAS that nevertheless perform the same way as current products that do use PFAS. Kosé has long been trying to minimise the use of PFAS but is also working to create products with the same functions as existing products using substitute substances.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5 years?**

PFASs have water-repellent and oil-repellent properties that contribute greatly to the functionality and useability of various products. If changes to prescriptions or new product development are required to comply with laws introduced to restrict the use of PFAS, we may see temporary cost inflation.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

Shiseido already has a track record and know-how in PFAS measures in overseas markets and is most likely in the sector to be able to maintain product performance without PFAS. Kosé is not seeing any impact on its earnings from regulations at present, but the company is aiming to take action in anticipation of future regulations.

MOST FAVOURABLY
EXPOSED

Company	Comment
Shiseido (4911)	The company has a track record in complying with regulations in countries overseas, and can cope with tighter regulations in Japan.
Kosé (4922)	The company has a track record in complying with regulations, and can cope with tighter regulations in Japan.

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analyst base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Hisae Kawamoto

[REDACTED]@ubs.com

UBS Research THESIS MAP

China Cosmetics

EXPOSURE

Current/Past use (Approx. 1.5% of sales)

IMPACT ON SECTOR

Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

China has not yet implemented any PFAS regulations on the cosmetics sector. In 2019, the Ministry of Ecology and Environment (MEE) issued regulations to prohibit the production, circulation, use, import and export of PFOS and PFOA. PFOS and PFOA are included in MEE's "list of key controlled new pollutants (2023)" for enhanced regulation, including prohibition of production, process and use. We have not seen regulations on key PFAS used in cosmetics, such as PTFE. Domestic cosmetics companies have not yet started to watch for PFAS, in our view.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

Unlikely. Leading domestic cosmetics companies are emphasizing R&D more, yet the focus is on product efficacy and functionality of raw materials. The discussion about PFAS in general remains minimal in China. We expect limited research on PFAS substitutes for domestic cosmetics companies at this stage. Yet the increasing popularity of "clean beauty" among the younger generation should be beneficial on this front.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5 years?**

We expect limited financial impact on the industry if no specific regulation on cosmetics sector is implemented by the regulators, or there is no significant shift in consumer mindset. Yet if industrywide regulation is implemented, we expect downside to sales growth and margins, mainly in the colour cosmetics category where the usage of PFAS is more common.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

We expect no significant impact of PFAS regulation on China's cosmetics sector at current stage. However, if we do observe tightening regulation, we would expect 1) international cosmetics companies (such as those in Japan, the EU and the US) that have a high level of preparedness due to local regulations to be favourably exposed, and 2) companies with less sales contribution from the colour cosmetics category to be more favourably exposed.

MOST FAVOURABLY
EXPOSED

Company	Comment
Botanee	Company focuses on products using plant extracts and for sensitive skin.
Proya	Leading domestic company and increasingly emphasizing R&D.
Bloomage	Strong R&D capabilities in cosmetics raw materials through synthetic biology.

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Ingrid Zhang

[REDACTED]@ubs.com

[REDACTED]

Xin Chen

[REDACTED]@ubs.com

[REDACTED]

Nate Zhou

[REDACTED]@ubs.com

[REDACTED]

UBS Research THESIS MAP

US Household & Personal Care/ US Beverages

EXPOSURE

Current/Past use (insignificant as % of sales)

IMPACT ON SECTOR

Growth:



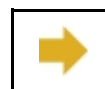
Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

In the US Household & Personal Care sector, companies that sell products that are primarily related to personal hygiene (dental floss, shampoo, shaving cream), sun and skin care, cosmetics, cookware, and cleaning products, are most directly impacted by tightening PFAS regulation. For example, soaps and detergents, which make up ~5% of COGS for the HPC sector, have been found to be slightly exposed to PFAS products during the manufacturing process. Thus far, a US\$5mn settlement early in 2023 by Thinx (brand under Kimberly-Clark) is the first major class action settlement related to PFAS within the space. However, we do not see widespread issues across our coverage universe, with some claims arising on a brand-specific basis. In such cases, companies could conceivably have to incorporate more expensive changes to their manufacturing processes to be compliant with regulation, but we expect the impact to be mostly de minimis.

For Beverage companies PFAS are less of a concern given the nature of the category, although there have historically been claims made around trace levels of PFAS in the sparkling water category, as well as some juices. As such, we do not expect a major response will be required. For Beverage Alcohol companies, PFAS appear to be essentially a non-issue.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

While most HPC and Beverage companies have laid out ambitious targets around more sustainable packaging and reducing the use of virgin plastics, concrete targets to reduce the use of PFAS are more difficult to find. Some have though – YETI has removed long-chain PFAS from all products, and is in the process of identifying replacements for short chain PFAS (which are currently used as a water repellent). Companies like Yeti have talked about a multi-year goal of eliminating PFAS from their products by finding substitutes. With outstanding claims facing the likes of PG, CLX and CL around the use of PFAS, we expect more companies to take a more proactive approach on reducing their exposure to these chemicals.

As mentioned above, we believe this issues is less applicable for Beverage companies. However, given the relative prevalence of this issue within the Packaged Food space, we expect it will be more top of mind for the likes of PepsiCo (who owns Frito Lay, Quaker Foods).

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5 years?**

We would not expect tightening PFAS regulations to have a meaningful financial impact on either the HPC or Beverage industry in the next 5 years. While we do not have an estimate for the significance of PFAS in companies' packaging for HPC, we see little reference within ESG reports, which leads us to believe that this will be more of a select, case-specific issue.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

Companies who are most favourably exposed to this scenario are those with either (1) little-to-no exposure to categories where PFAS are of elevated concern, or (2) plans already in place to pursue replacement materials.

MOST FAVOURABLY
EXPOSED

Company	Comment
Beverage Alcohol Companies (STZ, BFB, TAP, SAM)	Would not be impactful to business.
Non-Alcoholic Beverage Companies	Very limited perceived impact to the business.

Yeti Company is taking a front-footed approach to addressing the issue.

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURABLY
EXPOSED

Company	Comment
Estee Lauder	Cosmetics industry is likely to be one of the more impacted industries.
Procter & Gamble	Broad portfolio exposed to categories where PFAS are an elevated concern.

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Peter Grom

██████████@ubs.com

██████████

Bryan Adams

██████████@ubs.com

██████████

Allison LaFleur

██████████@ubs.com

██████████

UBS Research THESIS MAP

UBS Research THESIS MAP

US Restaurants

EXPOSURE

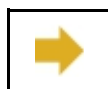
Current/Past use (low exposure)

IMPACT ON SECTOR

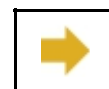
Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

Restaurant companies have low to no exposure from the tightening PFAS regulations. PFAS usage is found mostly in food packaging such as paper wraps and cardboard boxes. Quick service restaurants (QSR) such as RBI (Ticker: QSR), YUM and MCD aim to eliminate intentionally added PFAS from guest packaging in the near future (by 2025), while CMG, SHAK and WEN claim there is currently no intentionally added PFAS in their food packaging. SBUX has eliminated PFAS from US stores in 2022, and aims to do the same for all stores in 2023.

We were unable to confirm plans around PFAS for most casual dining restaurants and pizza companies, but these companies either generally have even lower PFAS exposure than QSR restaurants due to lower food takeout rate, or use packaging that does not contain PFAS (pizza boxes).

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

Restaurant companies that already eliminated PFAS from their food packaging should keep monitoring their supply chain for any added PFAS, while others should continue to work on phasing out PFAS by finding substitute material for food packaging, such as PLA (Polylactic Acid) or reusable packaging.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5 years?**

We expect low financial impact on the restaurant industry given the low exposure.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

Although the exposure to PFAS regulations is very low, we view QSR and fast casual restaurants as less favourably exposed given the higher usage of food packaging, whereas casual dining restaurants are most favourable given the lower usage of food packaging.

MOST FAVOURABLY
EXPOSED

Company	Comment
The Cheesecake Factory (CAKE)	
Bloomin' Brands (BLMN)	Casual dining restaurants have lower exposure to PFAS than QSR due to lower take-out and delivery ratio.
Texas Roadhouse (TXRH)	

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURABLY
EXPOSED

Company	Comment
Restaurant Brands International (QSR)	
Yum! Brands (YUM)	QSR restaurants have slightly higher exposure to PFAS given the higher usage of food packaging.
McDonald's (MCD)	

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Dennis Geiger	██████████@ubs.com	██████████
Paul Hao	██████████@ubs.com	██████████
Alexander Leach	██████████@ubs.com	██████████

UBS Research THESIS MAP

UBS Research THESIS MAP

US Packaged Food

EXPOSURE

Current/Past use (insignificant as a % of COGS)

IMPACT ON SECTOR

Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

Tightening PFAS regulations would primarily impact how Packaged Food companies source packaging materials. We estimate packaging is ~10% of most of our companies' COGS. While this is material, we do not think stricter PFAS regulations would have an outsized impact on increased packaging costs.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

The majority of Food companies have set ambitious 5- to 10-year targets to achieve 100% recyclable, reusable or compostable packaging as well as increase the share of post-consumer recycled content (usually 25%). Food packaging containing PFAS is likely to be difficult/impossible to compost, so such initiatives may also reduce PFAS exposure. With that said, we have not seen any meaningful action from Food companies to reduce PFAS exposure in food packaging.

Although there hasn't been meaningful legislation in the US for PFAS at the federal level, we expect the policy landscape to continue to evolve as a number of US states have begun to prohibit intentionally added PFAS in food packaging ([link](#)). Thus, we think the companies that begin to take early action on this front will be better insulated from future policy actions and improve consumer perceptions of their brands.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5 years?**

We do not expect tightening PFAS regulations to have a meaningful financial impact on Packaged Food companies in the next 5 years. While we do not have an estimate for the significance of PFAS in companies' packaging, we do not think it is meaningful given that we have not seen any reference to PFAS in annual ESG reports.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

We think companies with higher sales exposure to Europe are most favourably exposed over the long term to increasing PFAS regulations. While these companies may be impacted earlier on, we think they will make a concerted effort to source healthier packaging materials, which will aid both consumer brand perception and long term cost targets.

MOST FAVOURABLY
EXPOSED

Company	Comment
Nomad Foods (NOMD)	100% of sales in Europe. Likely to respond to environmental policies the quickest.
Mondelez International (MDLZ)	Significant EU exposure – would likely respond to regulations early on.

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

LEAST FAVOURABLY
EXPOSED

Company	Comment
The Hershey Company (HSY)	~8% international exposure – would be a late responder to international regulations.
Conagra Brands (CAG)	~9% international exposure – would be a late responder to international regulations.

Source: UBS estimates
Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Cody Ross	██████████@ubs.com	██████████
Brandon Cohen	██████████@ubs.com	██████████

UBS Research THESIS MAP

UBS Research THESIS MAP

China Food and Beverage

EXPOSURE

Current/Past limited use, since Stockholm 3 are already banned

IMPACT ON SECTOR

Growth:



Margins:



ROIC:



Valuation:

SECTOR IMPACT
(REGULATION)**Q: How are the companies likely to respond to tightening PFAS regulation?**

We think stricter PFAS regulation will have limited impact on domestic food and beverage companies, since Chinese Food Contact Materials (FCMs) have already banned the use of some PFAS since October 19, 2017. According to the National Food Safety Standard for the Use of Additives in FCMs and Articles (GB 9685-2016), the usage of PFAS, especially PFOS and PFOA, in FCMs and products is strictly prohibited, and only certain fluorine-containing small molecules or polymers can be used under certain restrictions. Moreover, related test standards on PFOS and PFOA in FCMs (GB 31604.35-2016) have been established and were implemented on April 19, 2017. Chinese F&B companies have been well prepared for Chinese domestic PFAS regulation, in our view.

SECTOR INNOVATION

Q: Are companies innovating today in ways that will prepare them for PFAS regulations?

The leading F&B companies have set targets to achieve green packaging, but there are few examples of specific innovations in reducing the usage of PFAS in China. Companies like Mengniu and Yili are taking actions such as developing 100% recyclable packaging material, purchasing raw materials with sustainable certification, and recycling used packages.

SECTOR IMPACT
(FINANCIAL)**Q: What will be the likely financial impact on the industry in the next 5 years?**

We do not expect tightening PFAS regulation to have a substantial financial impact on Chinese packaged food companies, given most companies have already banned the usage of some PFAS (Stockholm 3: PFOS, PFOA, PFHxS). If the scope of test standards is expanded to other PFAS, we expect the relevant testing cost to increase but still have a limited financial impact on the leading companies.

RELATIVE POSITION

Q: Which companies are most/least favourably exposed in the scenario above?

As mentioned above, we expect no impact of tightening regulation on Chinese F&B sector overall. We believe Mengniu and Yili will be among the most favourably exposed names given a high focus on supply chain sustainability and product safety.

MOST FAVOURABLY
EXPOSED

Company	Comment
Yili	Already restrict using some PFAS (Stockholm 3); low exposure to the EU market; achieved carbon peak in 2012 and aiming to achieve carbon neutrality in the whole industrial chain in 2050
Mengniu	Already restrict using some PFAS (Stockholm 3); low exposure to the EU market; aim to achieve carbon peak and carbon neutrality in 2030 and 2050

Source: UBS estimates

Note: This list contains stocks that may be impacted by specific scenarios. The scenarios described herein may play out over a multi-year period, whereas UBS equity analysts' base-case views are based on the next 12 months. All ratings are current, as shown in the most recent published UBS Research report relating to each company. These reports are available on UBS Neo.

Mark Yuan

@ubs.com

What is PFAS (in detail)

Which chemicals are included in the PFAS group?

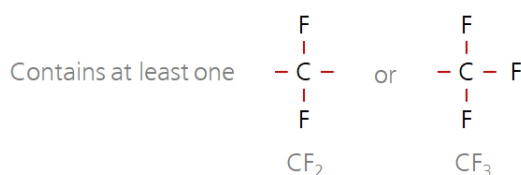
There is currently no globally accepted common definition for PFAS. The European Chemicals Agency defines the scope of the PFAS restriction similarly to the OECD definition. "Any substance that contains at least one fully fluorinated methyl (CF₃-) or methylene (-CF₂-) carbon atom (without any H/Cl/Br/I attached to it)" with a few fully degradable subgroups excluded ([ECHA proposal](#)). Canada's [State of PFAS Report](#) (May 2023) uses this same definition, but the UK's [Analysis](#) of the most appropriate regulatory management options for PFAS (April 2023) uses a narrower definition that excludes substances with only a single methylene group (-CF₂-).

The carbon-fluorine bond is the strongest known covalent bond in organic chemistry and complete breakdown of PFAS takes years to thousands of years (ECHA proposal Annex B). Of the thousands of PFAS types, around 250 are commercially relevant and 3 are listed as Stockholm Convention Persistent Organic Pollutants (see [Figure 5](#)). The most commonly used and studied examples in the PFAS group are Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS).

Figure 22: PFAS definition used by the European Chemicals Agency is in line with the latest OECD definition

Scope of European Chemicals Agency (ECHA) PFAS Restriction Proposal

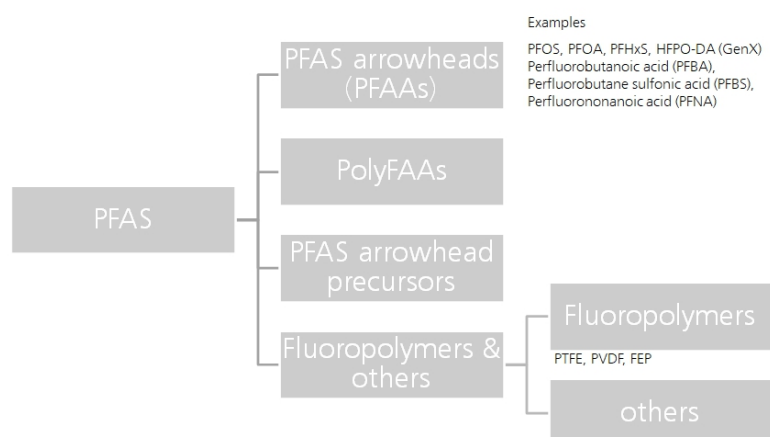
Any substance that contains at least one fully fluorinated methyl (CF₃-) or methylene (-CF₂-) carbon atom (without any H/Cl/Br/I attached to it).



Exclusions: PFAS subgroups that are shown to fully degrade under environmental conditions are excluded from the scope.

Source: UBS, based on ECHA Annex XV, European Chemicals Agency, <http://echa.europa.eu/>

Figure 23: PFAS subgroups and examples



Source: UBS, based on ECHA Annex XV, European Chemicals Agency, <http://echa.europa.eu/>

What are the properties of PFAS?

Common properties of PFAS are that they are water repellent, oil repellent, dirt repellent, and resistant to extreme temperatures, pressures and pH. This makes them very useful in cookware, food packaging, firefighting, and semiconductor manufacturing among many other uses. The time and pathway for various types of PFAS to break down have been studied but vary widely. It appears that complete breakdown of PFAS takes years to thousands of years. PFAS can be persistent in its original form, or persistent as an "arrowhead PFAS" after a "precursor PFAS" degrades into an arrowhead. For example, PFAAs (a type of PFAS arrowhead) degrade too slowly to be observable, so their half-lives could be decades, centuries or longer ([Parsons et al.](#)).

What is PFAS used for?

[Figure 24](#) shows common uses for PFAS according to the Interstate Technology & Regulatory Council. Those in the list would mostly be considered intentionally added or used PFAS, but it is also possible to have unintentionally added PFAS in final products. One example is using water or recycled materials that contain PFAS, and another example is where final moulded products contain traces of PFAS because PFAS polymers are commonly used to help stop materials from sticking to moulds.

Figure 24: PFAS uses

Industry/Application	PFAS Type	Documented Use and Examples of Some PFAS
Aviation and Aerospace	Polymer	Mechanical components made of fluoropolymers (such as PTFE and PFA tubing, piping, seals, gaskets, cables, and insulators)
	Nonpolymers	Hydraulic fluid additives made from PFSA salts (such as PFOS at about 0.1%) to prevent evaporation, fires, and corrosion
Automotive	Polymer	Mechanical components made of fluoropolymers, including wiring and cable, fuel delivery tubing, seals, bearings, gaskets and lubricants, and some polymer coatings on carpets
	Nonpolymers	Surface treatment for textiles, upholsteries, carpets, leather and exterior surfaces
Biocides (Herbicides and Pesticides)	Polymer	None reported
	Nonpolymers	Active ingredients such as short-chain sulfonamides in plant growth regulators and herbicides, and EtFOSA (sulfluramid) in ant and termite baits; inert enhancing ingredients in pesticides; PFPAs and PFPiAs as anti-foaming agents in solutions
Building and Construction	Polymer	Fluoropolymer membranes and coatings (such as PTFE, PVDF, and/or side-chain fluorinated polymers) in architectural materials (like fabrics, roofing membranes, metals, stone, tiles, concrete, radomes); adhesives, seals, caulks; additives in paints (for example, low- and no-VOC latex paints), varnishes, dyes, stains, sealants; surface treatment agent and laminates for conserving landmarks
	Nonpolymers	Additives in paints, coatings, and surface treatments (PASF- and fluorotelomer-based compounds, ammonium salt of PFHxA)
Cable and Wiring	Polymer	Coatings and jacketings made of fluoropolymers (such as PTFE and PVDF) for weathering, flame, and soil resistance, with cables used in many applications, including communication facilities, antennae, and computer networks
	Nonpolymers	None reported
Cosmetics/Personal Care Products	Polymer	Dental floss and micro powders used in creams and lotions.
	Nonpolymers	Cosmetics, shampoos, nail polish, eye makeup, denture cleaners
Electronics	Polymer	Fluoropolymers (such as PVDF and PTFE) used in insulators, solder sleeves, printed circuit boards, cell phones, computers, speakers, and transducers
	Nonpolymers	Flame retardants for polycarbonate resin (such as the potassium salt of PFBS)
Energy	Polymer	Fluoropolymer films (such as FEP, PVDF) to cover solar panel collectors, electrolyte fuel cells, PTFE expansion joint materials for power plants
	Nonpolymers	Fuel cell and battery electrolyte (such as the lithium salt of PFAAs)

Source: UBS based on ITRC (Interstate Technology & Regulatory Council). 2022. PFAS Technical and Regulatory Guidance Document and Fact Sheets PFAS-1. Washington, D.C.: Interstate Technology & Regulatory Council, PFAS Team. <https://pfas-1.itrcweb.org/>.

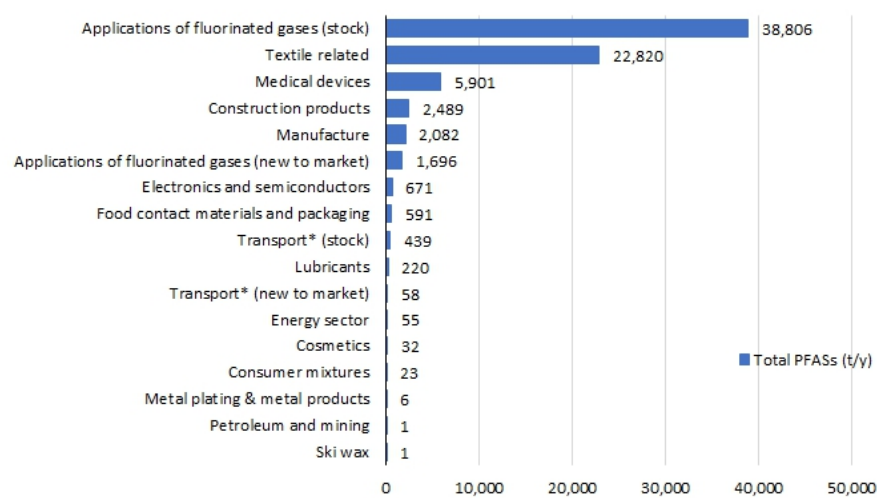
Figure 25: PFAS uses (continued)

Industry/Application	PFAS Type	Documented Use and Examples of Some PFAS
Firefighting/Safety	Polymer	Fluoropolymers used in firefighting equipment and protective clothing (such as those woven with PTFE). Other polymer coatings using side-chain fluorinated polymers)
	Nonpolymers	Coatings and materials used as water repellents and some Class B foam (may contain PFCAs, PFSA, and fluorotelomer-based derivatives), vapor suppression for flammable liquids (for example, gasoline storage)
Food Processing	Polymer	Fluoropolymer fabrication materials (such as PTFE) (liners for trays, ovens, grills)
	Nonpolymers	May be used as coatings on food packaging
Household Products	Polymer	Nonstick coatings (fluoropolymers such as PTFE); aftermarket treatment for textiles, upholsteries, carpets, and leather (such as FT-based side-chain fluorinated polymers)
	Nonpolymers	Aftermarket treatment for textiles, upholsteries, carpets, and leather (such as PASFs; floor polishes (such as the ammonium salt of PFDA), coatings, and floor finishes (PFPAs and PFPiAs) and cleaning agents and alkaline cleaners; automobile waxes; may include PFAAs, PASF- and fluorotelomer-based derivatives
Medical Products	Polymer	Fluoropolymers used in surgical patches, cardiovascular grafts, raw materials for human body implants (such as catheters, stents, needles, and other) given biocompatibility and extremely low coefficient of friction
	Nonpolymers	X-ray film, stain- and water-repellent protective medical fabrics (like surgical drapes and gowns) created from PASF- or fluorotelomer-based (meth)acrylate polymers and polyurethanes
Metal Plating	Polymer	None reported
	Nonpolymers	Wetting agent, mist suppression for harmful vapors, and surfactants (may include potassium, lithium, diethanolamine and ammonium salts of PFOS or 6:2 FTS)
Oil Production	Polymer	Lining of gas pipes
	Nonpolymers	Marketed for and potential instances of use in oil well production
Mining	Polymer	None reported
	Nonpolymers	Instances of surfactants used in ore mining flotation
Paper and Packaging	Polymer	Oil and grease and water repellent to paper, paperboard, molded pulp products (including food contact materials), and LDPE bags; examples include side-chain fluorinated polymers in which the PASF- or fluorotelomer-based alcohols or their acrylate or methacrylate esters are attached on side chains
	Nonpolymers	Phosphate ester salts (esterification of PASF or FT-based alcohols with phosphoric acid; PFPEs
PFAS Production	Polymer	Not applicable
	Nonpolymers	Emulsion polymerization processing aids for fluoropolymers (such as PTFE, FEP, PFA, PVDF), (co)monomer of side-chain fluorinated polymers; (co)monomer of fluoropolymers and to make fluoroelastomers; may use salts of long-chain PFCAs (such as PFOA and PFNA), salts of short-chain PFCAs (such as PFHxA), or PFECAs
Photolithography & Semiconductor	Polymer	Equipment raw materials (such as PFA) for molded wafer baskets to handle corrosive liquids and gases, use as fluids in mechanical vacuum pumps
	Nonpolymers	Photolithography (such as using PFOS) in manufacture of semiconductor chips
Textiles (Upholstery, Carpets), Leather, and Apparel	Polymer	Fluoropolymers (such as PTFE) are used in the construction of outdoor gear, clothing, and housewares; side-chain fluorinated polymers (such as PASF- or fluorotelomer-based (meth)acrylate polymers and -polyurethanes) may be used in oil- and water-repellent and stain release finishing and treatment coatings
	Nonpolymers	PFOA-based chromium treatment for paper and leather. Nonpolymer coatings used to treat textiles to provide oil- and water- repellent and stain release finishes

Source: UBS based on ITRC (Interstate Technology & Regulatory Council). 2022. PFAS Technical and Regulatory Guidance Document and Fact Sheets PFAS-1. Washington, D.C.: Interstate Technology & Regulatory Council, PFAS Team. <https://pfas-1.itrcweb.org/>.

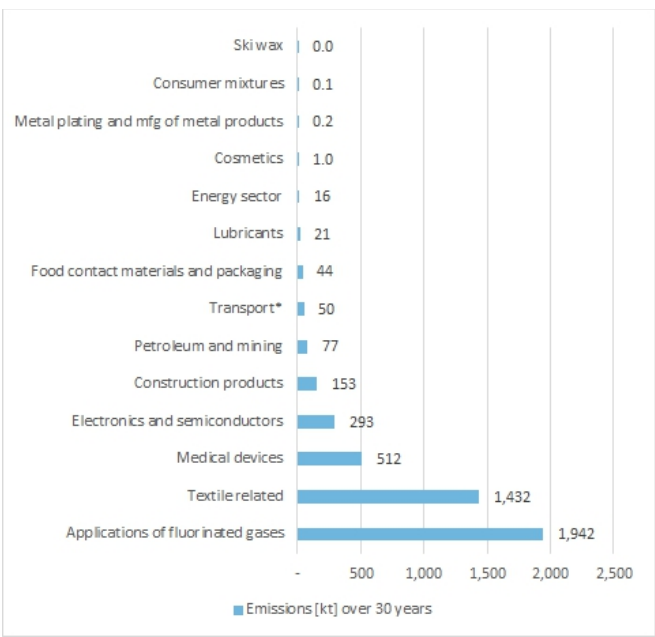
How much PFAS are used and emitted?

Figure 26: Estimated PFAS use in the European Economic Area in 2020



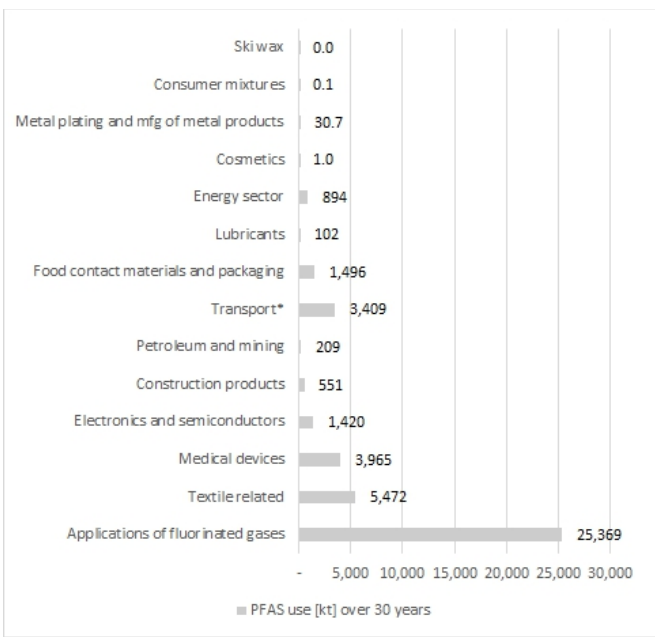
Source: UBS based on ECHA PFAS Restriction Proposal Annex XV, European Chemicals Agency, <http://echa.europa.eu/>
Note: Mid level estimates shown. * Transport PFAS use and emissions are mostly counted under "Applications of fluorinated gases."

Figure 27: Estimated PFAS use in the European Economic Area (EEA) over 30 years



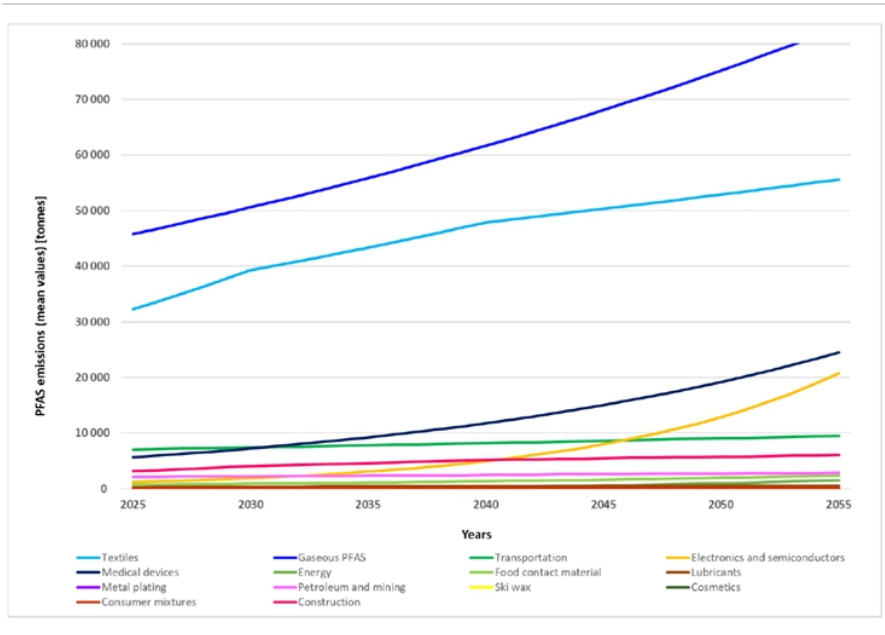
Source: UBS based on ECHA PFAS Restriction Proposal Annex XV, European Chemicals Agency, <http://echa.europa.eu/>, Note: * Transport PFAS use and emissions are mostly counted under "Applications of fluorinated gases." Cosmetics assumes a worst case scenario with 100% going to waste water

Figure 28: Estimated PFAS emissions in the EEA over 30 years



Source: UBS based on ECHA PFAS Restriction Proposal Annex XV, European Chemicals Agency, <http://echa.europa.eu/>
Note: * Transport PFAS use and emissions are mostly counted under "Applications of fluorinated gases."

Figure 29: Time paths of expected emissions from PFAS use over 30 years (2025-2055)



Source: ECHA PFAS Restriction Proposal Annex XV, European Chemicals Agency, <http://echa.europa.eu/>
Note: * Transport PFAS use and emissions are mostly counted under "Applications of fluorinated gases."
Cosmetics assumes a worst case scenario with 100% going to waste water

What are the main PFAS substitutes?

Figure 30: PFAS substitutes - summary of ECHA evidence review

Sector	Use	Alternatives					Company Cost Impact	Alternative substances	Comments
		Technical feasibility	Economic feasibility	No shortage	Functionality	Available			
Manufacture	Use of PFAS in manufacture of PTFE, PVDF, FKM	✓	✓	✓	-	currently	high		
	Use of PFAS in manufacture of polymeric PFASs other than PTFE, PVDF, FKM	✓	✓	-	-	by 2032	high		
Textile related	Home textiles	✓	✓	✓	lower	currently	low	Dendrimers, hybrid blends (silicone/hydrocarbon), hydrocarbons, polyurethanes, silicones	
	Consumer and professional apparel	✓	✓	✓	lower	currently	low	Dendrimers, hybrid blends (silicone/hydrocarbon), hydrocarbons, polyurethanes, silicones, alternative technologies	
	Personal protective equipment	some	-	-	lower	currently	high for some	Hydrocarbons, polyurethanes, silicones, alternative technologies	
	Medical textile applications (mattress protectors, gowns)	?		-	-	-	high	Polyurethane a possible alternative for membranes	High performance membranes lack alternatives and are high margin.
Food contact materials and packaging	Consumer cookware	✓	✓	✓	-	currently	high for some	Ceramic coatings, anodised aluminium, stainless steel	
	Industrial food and feed preparation (valves, conveyor belts, electronics)	✗		-	-	-	high		
	Non-stick coatings in industrial/professional bakeware	✓	✓	-	-	currently	low		Low substitution potential for some products.
	Paper & board packaging	✓	✓	✓	-	currently	high for some		Companies not yet producing PFAS-free options may face R&D costs
	Plastic packaging (plastic film)	✓	✓	-	likely lower	currently	?	Boron nitride, polyethylene waxes	
Metal & Mfg of metal products	Hard chrome plating	✓	✓	-	-	currently	low		Some report satisfactory performance of alternatives while others disagree.
	Decorative plating	✓	✓	✓	-	currently	low		Take up of alternatives has already occurred.
Consumer mixtures	Cleaners (for glass, metal, ceramic, carpet etc), dishwashing rinse aids	✓	✓	✓	-	currently	-	Silicones	
	Waxes (for floors/cars)	✓	✓	✓	-	currently	-	Car polishing: carnauba wax	
Cosmetics	Cosmetics	✓	✓	✓	similar	currently	low		
Applications for fluorinated gases	Refrigeration (except below)	✓	✓	✓	similar	currently	low	Natural refrigerants	
	Refrigeration (below -50C, in test equipment, in centrifuges)	✗		-	-		high		Natural refrigerants can pose a hazard due to flammability.
	Air conditioning and heat pumps	✓	✓	✓	-	currently	low	Hydrocarbon refrigerants, CO ₂ , ammonia	Regulations may prohibit the use of flammable alternatives.
	Foam blowing agents (for insulation)	✓	✓	✓	lower	currently	low	Hydrofluoroolefins (HFOs)	
	Solvents	✓	✓	✓	-	currently	low		Except for precision cleaning fluids, and possibly 3D printing.
	Propellants	✓	✓	✓	-	currently	-		Flammability/toxicity in some applications are a concern for alternatives.
	Fire suppressants	some	-	-	lower	currently	-	CO ₂ , water	Critical applications such as aviation prefer fluorinated gases for safety reasons.
	Insulating gas in electrical equipment (except below)	✓	✓	✓	similar	currently	low	Clean air technology, dry air (mix of nitrogen and oxygen) and vacuum	
	Insulating gas in electrical equipment (high voltage)	✗	-	-	-	-	-		Alternatives in development.

Source: UBS based on ECHA PFAS Restriction Proposal Annex XV, European Chemicals Agency, <http://echa.europa.eu/>

Note: checkmark signifies yes/available, "some" signifies yes/available for some uses, "?" signifies unknown, "X" signifies no/unavailable, and "-" signifies no information.

Figure 31: PFAS substitutes (Cont'd) - summary of ECHA evidence review

Sector	Use	Alternatives					Company Cost Impact	Alternative substances	Comments
		Technical feasibility	Economic feasibility	No shortage	Functionality	Available			
Medical devices	Medical devices (except below)	✗	-	-	-	-	-		Includes implants, hernia meshes, would treatment, tubes and catheters, packaging.
	Sterilization gases, propellants for inhalers	✓	✓	✓	-	currently	low		
Transport	Other than below (seals, O-rings and gaskets in engines etc)	✗	-	-	-	-	-		Sector as a whole has high dependence on PFAS in complex products. Where alternatives are available, testing, certification are needed.
	Hydraulic fluids	✗	-	-	-	-	-		
	Mobile air conditioning	some	-	-	-	depends	-	CO2 systems, secondary loop systems	Alternatives not yet available for use for combustion engine vehicles.
	Transport refrigeration	some	-	-	lower	depends	-	Active and passive CO2, ammonia	Alternatives take up space, so redesign is required.
	Sealing, wire insulation, LCD etc	?	?	-	-	currently	-		
Electronics & Semiconductors	Heat transfer fluids for immersion cooling	✓	?	-	-	-	-		
	Photolithography, fluoroelastomers, immersion cooling, plastic flame retardancy	✓	-	-	-	-	-		
	Semiconductor manufacturing process	✗	-	-	-	-	-		Proposal notes that stakeholder info suggests lack of alternatives but it is pointed out that there is "weak evidence" for this.
	Photovoltaic cells, sealing, gaskets, tubes, liners etc	✓	-	-	lower	currently	-	Hydrocarbon elastomers, PEEK for sealing in PEM fuel cells	
Energy	Membrane, reinforcement material	✓	-	✗	lower	2032	-	Hydrocarbon and PEEK membranes as alternatives in PEM fuel cells, but poor in durability; electrospun polybenzimidazole-type materials as alternatives to PTFE	
	Coatings & paints, ETFE film for greenhouses, window frames	✓	✓	✓	-	currently	low	Wood and metal as alternatives for PVC and HPL window frames laminated with fluoropolymers	
Construction Products	Membranes (with top coating)	✓	✓	✓	lower	currently	low		Some alternatives have less soil repellence and durability.
	PTFE thread sealing tape	some	some	✓	?	currently	?	Liquid/paste pipe thread	
	Polymeric PFASs used as processing aids for production of non-PFAS polymers/plastics	✓	✓	✓	-	currently	low	Boron nitride, siloxanes (reformations may be needed)	
	Surface protection/sealants	✓	✓	✓	lower	currently	low		
	Fluorosurfactants as wetting/levelling agents	✓	✓	✓	-	currently	low		
	Window film manufacturing	?	-	-	-	-	-		
	Lubricants in harsh conditions / for safety equipment	✗	-	-	-	-	high		High reformulation costs.
Petroleum and mining	Other lubricants	some	-	-	-	-	high		High reformulation costs.
	Non-polymeric PFAS applications (tracers, anti-foaming agents)	✓	✓	✓	-	currently	low		
	Fluoropolymer applications	✗	-	-	-	-	high		High reformulation costs.

Source: UBS based on ECHA PFAS Restriction Proposal Annex XV, European Chemicals Agency, <http://echa.europa.eu/>

Note: checkmark signifies yes/available, "some" signifies yes/available for some uses, "?" signifies unknown, "X" signifies no/unavailable, and "-" signifies no information.

What are the Health & Environmental Effects of PFAS

While health effects are difficult to determine, we note the potential seriousness of health conditions identified by peer-reviewed research. The main research challenges include: the existence of many types of PFAS, the types of PFAS used having changed overtime, PFAS accumulation overtime, and many different ways to be exposed to PFAS (drinking water, workplace exposure, food/packaging, and personal care products). Health impacts cited by the EPA include: lower fertility, developmental effects in children, increased risk of prostate, kidney, and testicular cancer, reduced immunity and vaccine response, among others.

Although health effects of less studied PFAS types are unclear, the persistence of almost all PFAS is well established. Either persistence in its original form, or persistence as "arrowhead PFAS" after a "precursor PFAS" degrades into an arrowhead. The EU proposal classifies PFAS as "highly persistent," and emphasizes the need to restrict PFAS at the source due to the problem of PFAS accumulation in the environment and organisms. To date, PFAS has been detected in mammals, fish, plant leaves, water bodies, and arctic ice among others (ECHA proposal Annex B). Although activated carbon and high pressure membranes are recognized as ways to remove some PFAS from drinking water (US EPA proposal), the EU proposal states that PFAS can be highly mobile, that it is difficult to decontaminate water or sites at a large-scale, and that an end-of-pipe solution is unachievable since PFAS is contained in many industrial and consumer products.

What we know and don't know

What we know

- PFOS and PFOA are harmful to human health
- Several types of PFAS including PFOS and PFOA are harmful to animal health
- PFAS accumulate in the environment and some wildlife
- PFAS are found all over the world, even in remote locations
- PFAS do not occur naturally except in some rare circumstances

What we don't know

- Limited evidence of the effects of PFAS other than PFOA, PFOS, PFHxS on human health
- Governments currently have different guidance on levels of PFAS considered safe for human health
- Impacts of higher PFAS levels on species and ecosystems
- Limited evidence on the ways humans are exposed to PFAS (associations have been made)

The health effects of PFOS, PFOA and other PFAS

Figure 32: Evidence of association between PFAS and health outcomes

Category	Outcome	Agency for Toxic Substances and Disease Registry	US Environmental Protection Agency	European Food Safety Authority	C8 Science Panel (considered PFOA only)	National Academies of Science, Engineering and Medicine (considered PFAS as a group)
Carcinogenicity	Kidney cancer	X (PFOA)	X (PFOA)	(-)	X (PFOA)	X (sufficient evidence)
	Testicular cancer	X (PFOA)	X (PFOA)	(-)	X (PFOA)	X (limited or suggestive evidence)
Metabolic Disease	Liver damage (increased liver enzyme levels)	X (PFOA, PFOS, PFHxS)	X (PFOA, PFOS)	X (PFOA, PFOS, PFHxS, PFNA)	(-)	X (limited or suggestive evidence)
	Increased serum cholesterol levels	X (PFOA, PFOS, PFNA, PFDA)	X (PFOA, PFOS)	X (PFOS, PFOA, PFNA)	X (PFOA)	X (sufficient evidence)
Immune	Decreased immune response (e.g., antibody response to vaccines)	X (PFOA, PFOS, PFHxS, PFNA, PFDA)	X (PFOA, PFOS)	X (PFOA, PFOS)	(-)	X (sufficient evidence)
Endocrine	Thyroid disease	(-)	X (PFOA, PFOS—limited or suggestive evidence)	(-)	X (PFOA)	X (limited or suggestive evidence)
Reproductive and Birth Outcomes	Decreased birthweight	X (PFOA, PFOS)	X (PFOA, PFOS)	X (PFOA, PFOS)	(-)	X (sufficient evidence)
	Preeclampsia/gestational hypertension	X (PFOA, PFOS)	X (PFOA, PFOS—limited or suggestive evidence)	(-)	X (PFOA)	X (limited or suggestive evidence)

Source: UBS based on White House Office of Science and Technology Policy [report](#).

Note: X (associated specific PFAS): outcomes where organizations have made a conclusion that the epidemiological evidence indicates there is an association. (-): determined not sufficient to make a conclusion on the association between any specific PFAS or PFAS as a class and the outcome

Figure 33: Significantly affected health endpoints in animal toxicity studies

Health Effect Endpoint	PFBA (4)	PFBS (4)	PFPeA (5)	PFHxA (6)	PFHxS (6)	HFPO-DA (6)	ADONA (7)	PFHpA (7)	FOSA (8)	PFOA (8)	PFOS (8)	PFNA (9)	PFDA (10)	PFUnA (11)	PFDoDA (12)
Body weight	Y	Y		Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y
Respiratory	Y	Y		Y	Y	Y				Y	Y	Y	Y		
Cardiovascular	Y	Y		Y	Y					Y	Y		Y		Y
Gastrointestinal	Y	Y		Y	Y					Y	Y	Y	Y		Y
Hematological	Y	Y		Y	Y	Y				Y	Y		Y	Y	Y
Musculoskeletal	Y	Y		Y	Y					Y	Y				
Hepatic	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Renal	Y	Y		Y	Y	Y		Y		Y	Y	Y	Y	Y	Y
Dermal	Y					Y		Y		Y	Y				
Ocular	Y	Y		Y		Y				Y	Y				
Endocrine	Y	Y		Y	Y	Y		Y		Y	Y	Y	Y		Y
Immunological	Y	Y		Y	Y	Y	Y	Y		Y	Y	Y	Y		
Neurological	Y	Y		Y	Y	Y			Y	Y	Y		Y		Y
Reproductive	Y	Y		Y	Y	Y	Y	Y		Y	Y	Y	Y		Y
Developmental	Y	Y		Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y
Other noncancer						Y				Y		Y			
Cancer						Y				Y	Y				

Source: UBS based on White House Office of Science and Technology Policy [report](#) reflecting studies until June 10, 2022

Note: Y = Significantly affected health endpoints in animal studies, (#) in the header row denotes the carbon number

Regulation (by country/region)

EU

The EU has acknowledged the dangers of PFAS chemicals, and the importance of reducing exposure to them, through the EU Chemicals Strategy ([here](#)). The regulation concerning the Registration, Evaluation, Authorisation and Restriction of chemicals (REACH, [here](#)) was first published in 2006 in part to “ensure a high level of protection of human health and the environment”. This was [amended](#) in 2021 to effectively ban some PFAS chemicals as they had been identified as “persistent” and “bioaccumulating”. These substances were associated with firefighting foam, high performance filters, implantable medical devices, and aspects of semiconductor manufacturing. This comes into effect from late February 2023. Recently, the European Chemicals Agency (ECHA) [published](#) a broad proposal to ban all PFAS in Europe following increasing evidence of human and environmental impacts. This will also come under the REACH regulation. The proposal suggests an 18-month transition period, after which a full ban would come into effect. An alternate suggestion includes two time-limited derogations depending on the availability of alternatives. A six-month consultation started in March 2023.

Other incoming regulations targeting PFAS include revisions of pollution legislations (including water and wastewater), proposals for which were [published](#) in October 2022. In the same month, the EU [adopted](#) a regulation to reduce the concentration of Persistent Organic Pollutants (POPs), including PFOA, in waste, highlighting that while POPs are usually no longer used in new products, they can be found in waste from some products.

Figure 34: Proposed and potential derogations in the ECHA PFAS Restriction Proposal

	5-year	12-year
Proposed derogations	a. polymerisation aids in the production of polymeric PFASs. This derogation does not apply to the production of PTFE, PVDF and FKM. e. textiles for the use in filtration and separation media used in high performance air and liquid applications in industrial or professional settings that require a combination of water- and oil repellence f. refrigerants in low temperature refrigeration below -50 °C p. refrigerants in mobile air conditioning-systems in combustion engine vehicles with mechanical compressors q. refrigerants in transport refrigeration other than in marine applications r. insulating gases in high-voltage switchgear (above 145 kV) fluoropolymers and perfluoropolyethers: a. food contact materials for the purpose of industrial and professional food and feed production e. proton-exchange membrane (PEM) fuel cells	b. textiles used in personal protective equipment (PPE) intended to protect users against risks as specified in Regulation (EU) 2016/425, Annex I, Risk Category III (a) and (c), c. textiles used in personal protective equipment (PPE) in professional firefighting activities intended to protect users against risks as specified in Regulation (EU) 2016/425, Annex I, Risk Category III (a) - (m), d. impregnation agents for re-impregnation of articles referred to in paragraph 5b and 5c (PPE) g. refrigerants in laboratory test and measurement equipment h. refrigerants in refrigerated centrifuges i. maintenance and refilling of existing Heating, Ventilation, Air Conditioning and Refrigeration (HVACR) equipment put on the market before [18 months after EoF] and for which no drop-in alternative exist j. refrigerants in HVACR-equipment in buildings where national safety standards and building codes prohibit the use of alternatives; k. industrial precision cleaning fluids l. cleaning fluids for use in oxygen-enriched environments m. clean fire suppressing agents where current alternatives damage the assets to be protected or pose a risk to human health n. diagnostic laboratory testing o. additives to hydraulic fluids for anti-erosion/anti-corrosion in hydraulic systems (incl. control valves) in aircraft and aerospace industry s. lubricants where the use takes place under harsh conditions or the use is needed for safe functioning and safety of equipment fluoropolymers and perfluoropolyethers: b. implantable medical devices (not including meshes, wound treatment products, tubes and catheters) c. tubes and catheters in medical devices d. coatings of Metered Dose Inhalers (MDIs) f. fluoropolymer applications in petroleum and mining industry.
Potential derogations	v. [hard chrome plating]; w. [foam blowing agents in expanded foam sprayed on site for building insulation]; fluoropolymers and perfluoropolyethers: g. [non-stick coatings in industrial and professional bakeware];	u. [textiles for the use in engine bays for noise and vibration insulation used in the automotive industry]; x. [industrial and professional use of solvent-based debinding systems in 3D printing]; y. [industrial and professional use of smoothing agents for polymer 3D printing applications]; z. [propellants for technical aerosols for applications where non-flammability and high technical performance of spray quality are required]; aa. [preservation of cultural paper-based materials]; bb. [cleaning and heat transfer: engineered fluids for medical devices]; cc. [membranes used for venting of medical devices]; dd. [use as refrigerants and for mobile air conditioning in vehicles in military applications]; ee. [the semiconductor manufacturing process]. fluoropolymers and perfluoropolyethers: h. [hernia meshes]; i. [wound treatment products]; j. [coating applications for medical devices other than Metered Dose Inhalers]; k. [Rigid gas permeable contact lenses and ophthalmic lenses]; l. [PCTFE-based packaging for medicinal preparations, medical devices and medical molecular diagnostics]; m. [PTFE in ophthalmic solutions packaging]; n. [packaging of terminally sterilised medical devices]; o. [applications affecting the proper functioning related to the safety of transport vehicles, and affecting the safety of operators, passengers or goods].

Source: UBS based on ECHA PFAS Restriction Proposal Annex XV

US

Our [US Electrical Equipment & Multi-Industry](#) analyst points out that PFAS has become a bigger and bigger issue in recent years as the number of litigations increased steadily (see our deep dive: [How Large is the PFAS Problem?](#)). Also the EPA's assessment of PFAS chemicals could potentially lead to clean up requirements (should there be enforceable max contamination levels). Past settlements & cleanup cost/reserves have been high (in aggregate in the billion USD). Further settlements / litigation outcomes are likely as our data shows that an estimated 6.3m people in the US alone live in an area of 5 miles

around a 'high contamination site' (>500ppt). Potential financial impacts could come from 1) bodily injury payments, 2) medical monitoring, 3) environmental cleanup and 4) litigation expenses - in addition to reputational damage.

In August 2022, the EPA proposed designating PFAS chemicals as "hazardous substances". This would require entities to report any releases of the substances that meet or exceed thresholds. This followed the EPA's announcement of more stringent guidelines on PFAS in the water supply, with the new threshold set at 0.02 parts per trillion (ppt) for PFOS, 0.004 ppt for PFOA, and 10 ppt for GenX (2022/6, [EPA](#)). The EPA also added 5 PFAS chemicals, HFPO-DA (aka GenX), PFOS, PFOA, PFNA, PFHxS, to the List of Regional Screening & Removal Management Levels (2022/5, [EPA](#)).

Figure 35: Number of PFAS entries in the US EPA Chemical Data Reporting Database 2016

Reporting Parent Company	Domestically Manufactured	Domestically Manufactured / Imported	Imported	Withheld	Confidential	Grand Total
3M COMPANY			4		1	5
AGC CHEMICALS AMERICAS, INC.			1	1		2
ATOTECH USA, INC.	1	1				2
DAIKIN AMERICA, INC.			7	2		9
Dow Corning Corporation	1					1
EXXON MOBIL CORPORATION			1			1
FORD MOTOR COMPANY			1			1
LANXESS CORPORATION			1			1
LINDE NORTH AMERICA, INC			1			1
PEACH STATE LABS INC	1		1			2
Peach State Labs LLC	1		1	2		4
SOLVAY SPECIALTY POLYMERS USA, LLC					3	3
SUMITOMO CORPORATION OF AMERICAS			1			1
The Chemours Co	1			20	17	38
TYCO FIRE PRODUCTS LP	8					8
ZEON CHEMICALS LP			1			1
Confidential Business Information	24			12	25	61

Source: UBS based on [OECD Comprehensive Global Database of PFAS](#) which lists PFAS entries for US EPA CDR 2016

UK

In April 2023, the UK published an [Analysis](#) of the most appropriate regulatory management options for PFAS. This report uses a narrower definition that excludes substances with only a single methylene group (-CF₂-) compared with the OECD/EU definition. The report concludes that the following options should be considered:

1. Prepare background dossiers to potentially support one or more UK REACH restrictions of PFAS
 - a. Use and disposal of fire fighting foam where non-PFAS alternatives are available
 - b. Other wide dispersive uses such as the application of coatings or use of cleaning agents
 - c. Manufacture and placing on the market of consumer articles from which PFAS are likely to be emitted (e.g. textiles, upholstery, leather, apparel, rugs and carpets, paints, varnishes, waxes and polishes, cleaning products, and food contact materials)
2. UK REACH authorization of PFAS used in processing aids used in manufacture and processing of fluorinated polymers
3. Further evaluation and investigation of substances that have been highlighted to be of concern
 - a. arrowhead substance TFA has been identified as a concern for developmental toxicity (HFCs, HFEs and HFOs group substances (i.e. a commercially significant, high tonnage group in the UK) are F-gases that may transform to TFA.)

The Drinking Water Inspectorate (England and Wales) has a guideline value of 0.1 micrograms per liter (100 ng/L) for PFOS and PFOA, and instructs companies to monitor 45 types of PFAS in drinking water ([DWI Report](#)). In Scotland, there is a standard of 0.1 micrograms per (100 ng/L) for the sum of 20 PFAS.

Japan

Following community calls for measurement of PFAS levels near US military bases in Japan that used PFAS for firefighting training, media interest in the issue has increased. Japan's Ministry of Environment convened a series of Expert Meetings on PFAS and Water Quality Targets for PFOS and PFOA in January. The two meetings will consider the latest scientific knowledge and domestic PFAS levels to make science-based recommendations on measures and water quality targets. Given that Japanese consumers see product quality and ingredients as the second and third most important factors after value for money when grocery shopping ([PulseCheck](#)), and have a high awareness around health impacts, we expect further PFAS restriction to be likely in Japan as well. The current government expert meetings as well as media interest are focused on PFOS and PFOA, but since PFOS production and import was banned in 2010, and most PFOA use was voluntarily phased out prior to the ban becoming effective in 2021, the key focus from investors' perspectives is likely to primarily be on [other types of PFAS](#).

Japanese companies manufacturing PFAS include Daikin Industries, AGC, AsahiKasei, Chemours Japan, Chemours-Mitsui Fluoroproducts (ownership: Mitsui Chemicals 50%, Chemours 50%), and DIC.

Asahi Kasei also supplies removal technologies for fluorine in water. The technology is described as reducing fluorine levels in water to 0.8mg per liter on its [website](#).

We held an expert event with Professor Koji Harada on June 23, where he explained that although Japanese PFAS regulation is being reconsidered, it is unlikely that Japan will follow the path taken by the EU to ban the whole PFAS group. He also expects research findings on the toxicity of PFAS other than the Stockholm 3 to be released over the next few years as research interest in the subject has increased.

Australia

Forever chemicals have been garnering more attention in the Australian media over the few years and the management of these chemicals is a high priority for federal and state environmental regulators. A [Fairfax investigation](#) in 2018 revealed PFAS contaminated sites around Australia and in 2020 the federal government agreed to settle three class actions over the contamination of communities affected by firefighting chemicals ([link here](#)). The Australian PFAS National Environmental Management Plan (NEMP) provides nationally determined guidance on the management of PFAS contamination in the environment. [NEMP 2.0](#) was published in May 2020 and the federal government is currently consulting on the [Draft NEMP 3.0](#) due to be released later this year. The plan recognises that in Australia, PFAS have been utilised for many decades in a wide range of consumer products and industrial processes. The NEMP panel of experts alludes to "fairly consistent reports of an association with several health effects" while explaining they are "generally small and within normal ranges for the whole population". The plan also talks about improved valuation, pricing and incentive mechanisms for example ensuring that the polluter pays and the price of goods and services be calculated on the whole life cycle costs including impact of PFAS on the environment and humans. The plan identifies many activities associated with PFAS contamination including aviation, automotive, agriculture, construction, manufacturing, telecommunications and waste management (see page 147 of the draft [plan](#)). Positively, in 2021 the 27th Australian Total Diet [Study](#), undertaken annually by the Food Standards ANZ body, found that levels of PFAS in the Australian food supply were "very low" and "consistently lower" than those found in overseas studies conducted in the EU, US, UK and China. Given these findings, we expect the new legislation to take a cautious approach and avoid being overly prescriptive; however, we will review the final plan closely once it is released.

PFAS Litigation

PFAS litigation is the most significant risk for PFAS producers, and though a number of cases have been settled recently, these cases mostly regarding past emissions of Stockholm 3 chemicals. If PFAS regulations are tightened further to other types of PFAS beyond the Stockholm 3, as is being proposed in the EU, and through water regulations in the US, there could be more scope for litigation. In this respect, the recent US\$10.3bn 3M settlement in June 2023 with US public water suppliers that covers PFOA, PFOS as well as all other PFAS, is comprehensive and improves visibility ([report](#)). Note however that personal injury settlements related to PFAS (i.e., medical monitoring & compensation) would be incremental to clean-up costs. Legal experts we spoke with view this as a slower moving process and do not expect personal injury bellwether cases to start until the later part of 2024. In addition, potential EU liabilities remain a concern for investors. According to the filings, 3M will have the option to terminate the settlement if enough class members opt out, so this deal could ultimately exclude a high number of hold-outs, particularly the municipalities who feel they have the best & strongest cases.

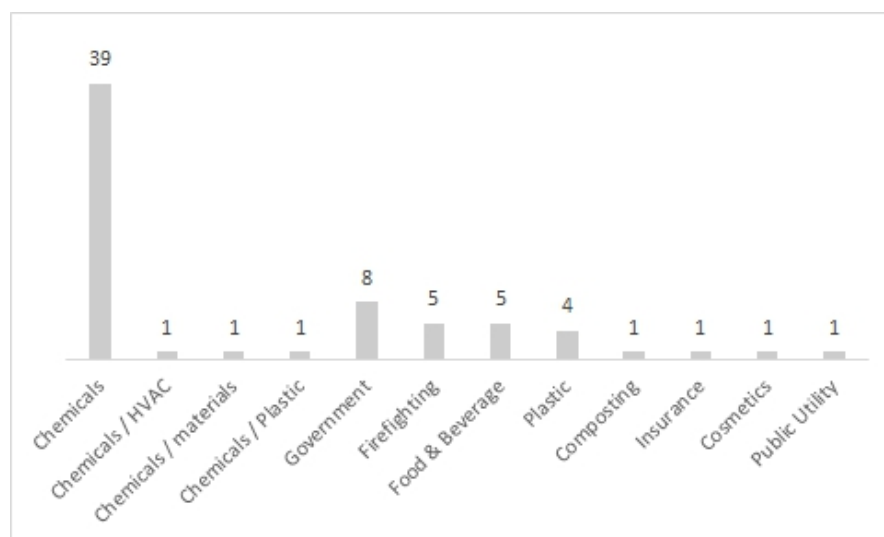
The EPA has proposed to regulate some PFAS as hazardous under the Superfund law (CERCLA). In January 2022, the EPA proposed to add PFOS and PFOA to the hazardous substances list, and in April 2023, the EPA started seeking public input on whether 7⁽⁶⁾ additional PFAS should be added to the list ([source](#)). This would allow the government and private entities to date are mostly chemicals companies, but also include HVAC, fluoropolymer materials, and plastics companies. Manufacturers of firefighting products have also been named in litigation over the last few years, and more recently, food & beverage, cosmetic and public utilities have also been sued. Most recently, on May 31, Washington State filed a lawsuit against 20 PFAS manufacturers listed below ([link](#)).

- 3M Company,
- AGC Chemicals Americas Inc.,
- Amerex Corporation,
- Archroma U.S. Inc.,
- Arkema Inc.,
- BASF Corporation,
- Buckeye Fire Equipment Company,
- Carrier Fire & Security Americas Corporation,
- Carrier Global Corporation,
- ChemDesign Products Inc.,
- Chemguard Inc.,
- Clariant Corporation,
- Dynax Corporation,
- EIDP Inc. f/k/a E. I. du Pont de Nemours and Company,
- Kidde PLC Inc.,
- National Foam Inc.,
- The Chemours Company,
- Tyco Fire Products LP,
- Corteva Inc.,
- DuPont de Nemours Inc.

Based on prior cases and expert discussions, we see costs arising for 1) clean-up, 2) medical monitoring, 3) medical compensation, and 4) diminished property values.

⁶. PFBS, PFHxS, PFNA, HFPO-DA, PFBA, PFHxA, and PFDA

Figure 36: Number of significant developments in court cases in the US between January 2021 to March 2023



Source: UBS based on Alston & Bird

Note: The data above count both individuals and governments suing corporations and the other way around. If no corporate is involved in the case, but government is involved, that is counted under "Government."

Figure 37: PFAS & CAEv2 liability scenarios (US Multi-industry team base case estimate in gray)

UBS Assumptions						Estimated Liabilities (\$Billion, UBSe)						
Population Affected	\$/Person			% of Population Included		PFAS			Total PFAS	NPV	CAEv2	Total
	Clean-up	Medical Monitoring	Medical Compensation	Medical Monitoring	Medical Compensation	Clean-up	Medical Monitoring	Medical Compensation				
6.55M	\$1,000	\$3,000	\$190,000	87.50%	4.38%	\$6.55	\$17.19	\$54.45	\$78.19	\$47.46	\$7.08	\$54.55
13.05M	\$1,000	\$3,000	\$190,000	87.50%	4.38%	\$13.05	\$34.26	\$108.48	\$155.78	\$94.56	\$7.08	\$101.65
19.55M	\$1,000	\$3,000	\$190,000	87.50%	4.38%	\$19.55	\$51.32	\$162.51	\$233.38	\$141.66	\$7.08	\$148.75
27.05M	\$1,000	\$3,000	\$190,000	87.50%	4.38%	\$27.05	\$71.01	\$224.85	\$322.91	\$196.01	\$7.08	\$203.09
34.55M	\$1,000	\$3,000	\$190,000	87.50%	4.38%	\$34.55	\$90.69	\$287.20	\$412.44	\$250.36	\$7.08	\$257.44
6.55M	\$1,000	-	-	-	-	\$6.55	\$1.00	\$3.00	\$10.55	\$6.40	\$7.08	\$13.49
13.05M	\$875	-	-	-	-	\$11.42	\$5.00	\$15.00	\$31.42	\$19.07	\$7.08	\$26.15
19.55M	\$750	-	-	-	-	\$14.66	\$9.00	\$27.00	\$50.66	\$30.75	\$7.08	\$37.84
27.05M	\$625	-	-	-	-	\$16.91	\$13.00	\$39.00	\$68.91	\$41.83	\$7.08	\$48.91
34.55M	\$500	-	-	-	-	\$17.28	\$17.00	\$51.00	\$85.28	\$51.76	\$7.08	\$58.85

Source: UBS estimates, original report: [First Read: 3M Company "More PFAS Headlines: Mediation w/ City of Stuart FL..."](#)

Figure 38: PFAS environmental cleanup costs: settled case, remediation, or estimated

Location	Population	Cost	Cost / Person
Barnstable, MA ₁	18,000	\$2,950,000	\$164
Westfield, MA ₂	41,000	\$13,000,000	\$317
Hoosick Falls, NY ₃	3,500	\$7,000,000	\$2,000
Decatur, AL ₄	53,000	\$63,400,000	\$1,196
Petersburgh, NY ₅	1,500	\$1,200,000	\$800
New York State ₆	4,485,000	\$2,197,650,000	\$490
Minnesota ₇	150,000	\$850,000,000	\$5,667
Average			\$1,519
Median			\$800

Source: UBS analysis and estimates based on court filings (3,7), news sources (1,2,4), and expert discussions (5,6). Note: due to data availability, in 3 and 4 we present our estimate of cleanup costs based on publicly available settlement amounts. Original report: [First Read: 3M Company "More PFAS Headlines: Mediation w/ City of Stuart FL..."](#)

Figure 39: US PFAS Litigation Summary (as of 2021)

3M Company	# Lawsuits	AFFF/PFOA/Other	Comment
State Attorneys General Litigation related to PFAS			
New York	4	AFFF	Transferred to the AFFF MDL
Ohio	1	AFFF	Transferred to the MDL
New Jersey	3	PFOA & AFFF	AFFF lawsuit transferred to the MDL
New Hampshire	2	AFFF & non-AFFF	AFFF case transferred to the MDL, non-AFFF case proceeding in state court
Vermont	2	AFFF & non-AFFF	
Michigan	2	AFFF & non-AFFF	One case transferred to MDL; motion filed to transfer the other case
Guam	1	AFFF	Transferred to the AFFF MDL
Commonwealth of Northern Mariana Islands	1	AFFF	Transferred to the AFFF MDL
Mississippi	1	AFFF	Filed directly with the AFFF MDL
Alaska		AFFF & Other	
Aqueous Film Forming Foam (AFFF) Environmental Litigation			
Total alleging injuries or damages by AFFF	1076		Filed in various states and federal courts; vast majority in SC MDL
Subsidiaries of Valero Energy Corporation	7	AFFF	2 cases transferred to the AFFF MDL
Other PFAS-related Product and Environmental Litigation			
New York	45	PFOA	40 individual cases, 1 putative class action in US District Court; 4 cases in NY
Michigan	278		Consolidated putative class action in US District Court; individual actions
Alabama & Georgia	6		3 state court cases (water utilities); 2 putative class actions in federal court
California		AFFF & Other	One case in AFFF MDL; others in state court (local water providers)
Delaware	1		Putative class action
New Jersey	8		Actions brought by local governments, water providers, individuals
Ohio	1		Putative class action (firefighters exposed to foams) in US District Court
West Virginia	1		Transferred to the AFFF MDL
Johnson Controls (Chemguard and Tyco Fire Products)			
AFFF Putative Class Actions			
Federal Courts originating from various states	31		Transferred to the AFFF MDL
AFFF Individual or Mass Actions			
State or federal court in various states	1000		~7,000 plaintiffs in CO, ~126 in NY, ~1,000 other; all but five in the MDL
AFFF Municipal Cases			
Federal & state courts, municipal or water provider plaintiffs	87	PFOS & PFOA	All but five of these cases in the MDL
State or U.S. Territory Attorneys General Litigation related to AFFF			
New York	4	PFOS & PFOA	Transferred to the AFFF MDL
Ohio	1	PFOS & PFOA	Transferred to the AFFF MDL
New Hampshire, Vermont, New Jersey	3	PFOS & PFOA	Transferred to the AFFF MDL
Guam	1	PFOS & PFOA	Transferred to the AFFF MDL
Commonwealth of the Northern Mariana Islands	1	PFOS & PFOA	Transferred to the AFFF MDL
Michigan	2	PFOS & PFOA	Federal action has been transferred to the MDL
Mississippi	1	PFOS & PFOA	Filed directly with the MDL
Alaska	1	PFOS & PFOA	This complaint has not yet been served
Kalispel Tribe of Indians and two tribal corporations	1	AFFF	Transferred to the AFFF MDL
Honeywell			
New York	4	PFOA	
Carrier			
Aqueous Film Forming Foam Litigation			
Putative class actions and other lawsuits	>900	AFFF	Transferred to the AFFF MDL
State, municipal and water utility plaintiffs	Several	AFFF	
Oil refining companies in the U.S.	<10	AFFF	Product liability claims related to legacy sales of AFFF

Source: Company Filings, UBS

PFAS Levels Data

UBS Evidence Lab has published a US PFAS Water Contamination Tracker ([> Access Dataset](#)) to estimate the population living near high-PFAS sites. PFAS levels are generally high near airports, army bases and PFAS manufacturing sites, but is also detected at lower levels far from these sites or even far from human populations. When using PFAS levels data, it is important to compare the detected levels with health advisory levels and also to have sufficient data points to ensure that erroneous outliers are not mistakenly interpreted as representative.

The Environmental Working Group has put together a global map based on studies of PFAS levels in wildlife.

https://www.ewg.org/interactive-maps/pfas_in_wildlife/map/

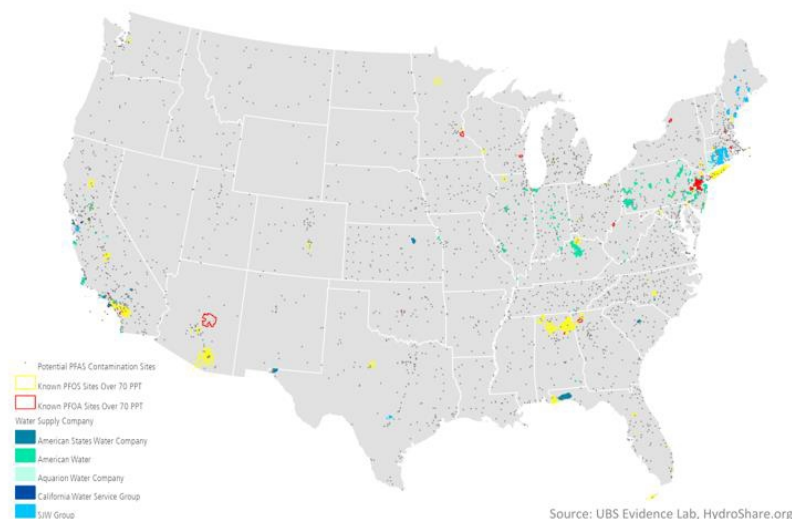
US

The UBS Evidence Lab data shows utility water service areas and known or potential PFAS contaminations based on 70 ppt or greater PFAS levels. We include American Water, American States Water, California Water, Eversource Energy's Aquarion and SJW Group. Essential Utilities had already had a plan to ensure that unfinished water would not exceed 13 parts per trillion for PFOA, PFOS and PFNA compounds. (See US Water Utilities ["UBS Evidence Lab Inside: PFAS Mapping and Proposed..."](#) for details.)

The UBS Multi-Industry team found that there were 6.3 million Americans living within 5 miles of a high contamination site (See US Electrical Equipment & Multi-Industry ["How large is the PFAS problem?..."](#) for details).

Figure 40: Known and Potential PFAS Contamination Sites and Water Utility Service Areas

Water Supply Company



Source: UBS Evidence Lab, US EPA Site for Drinking Water Contamination Sites, Base Realignment and Closure (BRAC) Sites, Air Force Administration Record for Military Sites, State of Michigan PFAS Sites, State of California PFAS sites, HydroShare.org, ([> Access Dataset](#))

The Environmental Working Group has also mapped PFAS levels data. https://www.ewg.org/interactive-maps/pfas_contamination/

EU & UK

A map of PFAS levels in Europe was produced by Le Monde, followed by maps for individual countries as well. The map for Europe shows 17,000 sites where PFAS was detected at or above 10 nanograms per liter.

Japan

The Japanese public broadcaster, NHK, mapped PFOS and PFOA levels in rivers/lakes and groundwater based on Ministry of Environment and other data sources. Higher levels of PFOS and PFOA are found in Okinawa and Kanagawa for rivers/lakes, and Osaka, Okinawa, and Tokyo for groundwater. Water utilities have policies to check PFOS+PFOA levels and stop sourcing water from a location if the level exceeds the current guidance of 50 nanograms per liter.

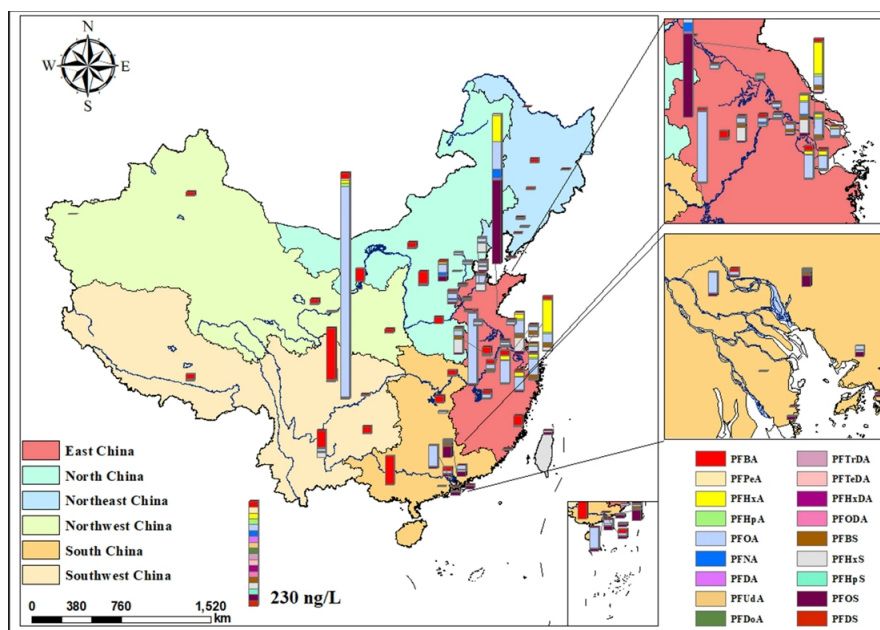
<https://www.nhk.jp/p/gendai/ts/R7Y6NGLJ6G/blog/bl/pkEldmVQ6R/bp/pyD6dG2wOM/>

Data on PFAS levels other than PFOS and PFOA are very limited. The Ministry of Environment published some figures [here](#) that shows PFHxS was detected in 32 of 47 sites tested, but levels were generally low ranging from less than 0.1 to 28 nanograms per liter.

China

Liu, Qu and Huang studied PFAS in drinking water based on 526 drinking water samples from 66 cities. The mean sum of PFAS in drinking water ranged from 0.1 to 502.9 nanograms per liter in various cities. The different colours in each bar on the map in [Figure 41](#) different types of PFAS.

Figure 41: PFAS in drinking water in China according to a 2021 study by Liu, Qu and Huang



Source: Liu, L., Qu, Y., Huang, J. et al. Per- and polyfluoroalkyl substances (PFASs) in Chinese drinking water: risk assessment and geographical distribution. *Environ Sci Eur* 33, 6 (2021). <https://doi.org/10.1186/s12302-020-00425-3>

<https://enveurope.springeropen.com/articles/10.1186/s12302-020-00425-3#rightslink>

Appendix

Main PFAS subgroups

Figure 42: Main PFAS subgroups according to the European Chemicals Agency



Source: ECHA Annex XV, European Chemicals Agency, <http://echa.europa.eu/>

Note: Main PFAS subgroups, including the subgroup of stable metabolites (PFAAs) or 'arrowheads' (pink) and the precursors to the PFAAs (red).

PFAS related UBS publication list

[First Read: 3M Company "PFAS Settlement Improves Visibility & Comes..."](#), 23 June 2023

[First Read: 3M Company "More PFAS Headlines: Mediation w/ City of..."](#), 5 June 2023.

[First Read: 3M Company "Litigation Channel Check Post PFAS Latest"](#), 2 June 2023.

[N.A. Chems & Pkg'g "Agreement reached on US PFAS water contamination;..."](#), 2 June 2023.

[N.A. Chems & Pkg'g "Nearing potential PFAS settlement catalyst re CC/DD"](#), 29 May 2023.

[California Water Service Group "1Q'23 Light on Regulatory Timing; PFAS Update"](#), 27 April 2023.

[Chemicals Sector "PFAS - what do the Report and Accounts say?"](#), 12 April 2023.

[UBS Evidence Lab inside Video: PFAS Mapping and Proposed Rule](#), 23 March 2023.

[US Water Utilities "UBS Evidence Lab Inside: PFAS Mapping..."](#), 15 March 2023.

[Global Sustainability "永遠の化学物質\(PFAS\): 欧米/日本/豪州で進展加速"](#), 14 February 2023.

[Global Sustainability "Forever Chemicals \(PFAS\): Developments pick up..."](#), 14 February 2023.

[US Water Utilities "PA Issues PFAS Rules"](#), 23 January 2023.

[First Read: 3M Company "Plan to Phase Out PFAS Production by YE 2025"](#), 20 December 2022.

[First Read: US Electrical Equipment & Multi-Industry "EPA Adds More PFAS..."](#), 19 May 2022.

[3M Company "3M - Takeaways from our PFAS Expert Call"](#), 24 June 2021.

[Johnson Controls International plc "JCI - Takeaways from our PFAS Expert Call"](#), 24 June 2021.

[The Chemours Company "UBS Expert Update re PFAS"](#), 21 June 2021.

[US Electrical Equipment & Multi-Industry "Sector Weekly: Recap of our PFAS..."](#), 18 June 2021.

[US Electrical Equipment & Multi-Industry "Expert Call on PFAS: ..."](#), 15 June 2021.

[US Electrical Equipment & Multi-Industry "How large is the PFAS problem?"](#), 10 June 2021.

[Video: Chemicals: 2Q21 prospects, CEO pay, Wacker, PFAS litigation & battery ..."](#), 27 May 2021.

[Consumer Chemicals Sector "ESG in focus: PFAS in cosmetics ..."](#), 14 May 2021.

[Chemicals Sector "PFAS litigation risks – who is affected and what..."](#), 3 May 2021.

Valuation Method and Risk Statement

Valuations for Media are based on multiples analysis. Key risks for media networks include the health and sustainability of the Pay TV ecosystem as well as advertising, particularly television advertising, which is sensitive to overall macroeconomic conditions (GDP and consume spending). Changes in growth expectations for the global economy, either positive or negative, could impact our forecasts, ratings and price targets.

Required Disclosures

This document has been prepared by UBS Securities Japan Co., Ltd., an affiliate of UBS AG. UBS AG, its subsidiaries, branches and affiliates, including Credit Suisse AG and its subsidiaries, branches and affiliates are referred to herein as "UBS".

For information on the ways in which UBS manages conflicts and maintains independence of its UBS Global Research product; historical performance information; certain additional disclosures concerning UBS Global Research recommendations; and terms and conditions for certain third party data used in research report, please visit <https://www.ubs.com/disclosures>. Unless otherwise indicated, information and data in this report are based on company disclosures including but not limited to annual, interim, quarterly reports and other company announcements. The figures contained in performance charts refer to the past; past performance is not a reliable indicator of future results. Additional information will be made available upon request. UBS Securities Co. Limited is licensed to conduct securities investment consultancy businesses by the China Securities Regulatory Commission. UBS acts or may act as principal in the debt securities (or in related derivatives) that may be the subject of this report. This recommendation was finalized on: 05 July 2023 08:46 AM GMT. UBS has designated certain UBS Global Research department members as Derivatives Research Analysts where those department members publish research principally on the analysis of the price or market for a derivative, and provide information reasonably sufficient upon which to base a decision to enter into a derivatives transaction. Where Derivatives Research Analysts co-author research reports with Equity Research Analysts or Economists, the Derivatives Research Analyst is responsible for the derivatives investment views, forecasts, and/or recommendations. **Quantitative Research Review:** UBS Global Research publishes a quantitative assessment of its analysts' responses to certain questions about the likelihood of an occurrence of a number of short term factors in a product known as the 'Quantitative Research Review'. Views contained in this assessment on a particular stock reflect only the views on those short term factors which are a different timeframe to the 12-month timeframe reflected in any equity rating set out in this note. For the latest responses, please see the Quantitative Research Review Addendum at the back of this report, where applicable. For previous responses please make reference to (i) previous UBS Global Research reports; and (ii) where no applicable research report was published that month, the Quantitative Research Review which can be found at <https://neo.ubs.com/quantitative>, or contact your UBS sales representative for access to the report or the Quantitative Research Team on neor@ubs.com. A consolidated report which contains all responses is also available and again you should contact your UBS sales representative for details and pricing or the Quantitative Research team on the email above.

Analyst Certification:

Each research analyst primarily responsible for the content of this research report, in whole or in part, certifies that with respect to each security or issuer that the analyst covered in this report: (1) all of the views expressed accurately reflect his or her personal views about those securities or issuers and were prepared in an independent manner, including with respect to UBS, and (2) no part of his or her compensation was, is, or will be, directly or indirectly, related to the specific recommendations or views expressed by that research analyst in the research report.

UBS Global Research: Global Equity Rating Definitions

12-Month Rating	Definition	Coverage ¹	IB Services ²
Buy	FSR is > 6% above the MRA.	54%	22%
Neutral	FSR is between -6% and 6% of the MRA.	36%	21%
Sell	FSR is > 6% below the MRA.	10%	18%
Short-Term Rating	Definition	Coverage ³	IB Services ⁴
Buy	Stock price expected to rise within three months from the time the rating was assigned because of a specific catalyst or event.	<1%	<1%
Sell	Stock price expected to fall within three months from the time the rating was assigned because of a specific catalyst or event.	<1%	<1%

Source: UBS. Rating allocations are as of 31 March 2023.

1:Percentage of companies under coverage globally within the 12-month rating category.

2:Percentage of companies within the 12-month rating category for which investment banking (IB) services were provided within the past 12 months.

3:Percentage of companies under coverage globally within the Short-Term rating category.

4:Percentage of companies within the Short-Term rating category for which investment banking (IB) services were provided within the past 12 months.

KEY DEFINITIONS: Forecast Stock Return (FSR) is defined as expected percentage price appreciation plus gross dividend yield over the next 12 months. In some cases, this yield may be based on accrued dividends. **Market Return Assumption (MRA)** is defined as the one-year local market interest rate plus 5% (a proxy for, and not a forecast of, the equity risk premium). **Under Review (UR)** Stocks may be flagged as UR by the analyst, indicating that the stock's price target and/or rating are subject to possible change in the near term, usually in response to an event that may affect the investment case or valuation. **Short-Term Ratings** reflect the expected near-term (up to three months) performance of the stock and do not reflect any change in the fundamental view or investment case. **Equity Price Targets** have an investment horizon of 12 months.

EXCEPTIONS AND SPECIAL CASES: UK and European Investment Fund ratings and definitions are: **Buy:** Positive on factors such as structure, management, performance record, discount; **Neutral:** Neutral on factors such as structure, management, performance record, discount; **Sell:** Negative on factors such as structure, management, performance record, discount. **Core Banding Exceptions (CBE):** Exceptions to the standard +/-6% bands may be granted by the Investment Review Committee (IRC). Factors considered by the IRC include the stock's volatility and the credit spread of the respective company's debt. As a result, stocks deemed to be very high or low risk may be subject to higher or lower bands as they relate to the rating. When such exceptions apply, they will be identified in the Company Disclosures table in the relevant research piece.

Research analysts contributing to this report who are employed by any non-US affiliate of UBS Securities LLC are not registered/qualified as research analysts with FINRA. Such analysts may not be associated persons of UBS Securities LLC and therefore are not subject to the FINRA restrictions on communications with a subject company, public appearances, and trading securities held by a research analyst account. The name of each affiliate and analyst employed by that affiliate contributing to this report, if any, follows.

UBS AG London Branch: Francois-Xavier Bouvignies, Geoff Haire, Harry Blaiklock, CFA, Sreedhar Mahamkali, Victoria Kalb. **UBS Securities Australia Ltd:** Camille Wynter. **UBS Securities Co. Limited:** Amily Guo, Ingrid Zhang, Mark Yuan. **UBS Securities Japan Co., Ltd.:** Hikaru Mizuno, Hisae Kawamoto, Kenji Yasui, Leigha Miyata, Nozomi Moriya, Shingo Hirata, CFA, Shunta Omura. **UBS Securities LLC:** Chris Snyder, CFA, Cody Ross, Damian Karas, CFA, Dennis Geiger, CFA, Gregg Orrill, Jay Sole, Jon Windham, CFA, Joshua Spector, CFA, Mauricio Serna, CFA, Neal Burk, Peter Grom, Shneur Z. Gershuni, CFA. **UBS Securities Pte. Ltd., Seoul Branch:** Jaehyung Choi.

Unless otherwise indicated, please refer to the Valuation and Risk sections within the body of this report. For a complete set of disclosure statements associated with the companies discussed in this report, including information on valuation and risk, please contact UBS Securities LLC, 1285 Avenue of Americas, New York, NY 10019, USA, Attention: Investment Research.

Additional Prices: BASF SE, €44.69 (04 Jul 2023); Bloomin' Brands Inc, US\$27.34 (03 Jul 2023); Nomad Foods Ltd, US\$17.58 (03 Jul 2023); Zalando SE, €25.95 (04 Jul 2023); Restaurant Brands International, US\$77.26 (03 Jul 2023); The Chemours Company, US\$37.23 (03 Jul 2023); Proya Cosmetics, Rmb110.83 (05 Jul 2023); Bloomage Biotechnology, Rmb91.17 (05 Jul 2023); Yunnan Botanee Bio-Technology, Rmb90.99 (05 Jul 2023); China Mengniu Dairy, HK\$30.50 (05 Jul 2023); A.O. Smith Corporation, US\$72.37 (03 Jul 2023); Honeywell International Inc, US\$208.30 (03 Jul 2023); 3M Company, US\$101.14 (03 Jul 2023); Kohl's Corp, US\$24.50 (03 Jul 2023); Carrier Global Corp, US\$50.04 (03 Jul 2023); LG Household & Health Care, Won444500 (05 Jul 2023); Shin-Etsu Chemical, ¥4827 (05 Jul 2023); Macy's Inc, US\$16.48 (03 Jul 2023); Asahi Kasei, ¥990 (05 Jul 2023); Eversource Energy, US\$71.05 (03 Jul 2023); Rohm, ¥14070 (05 Jul 2023); Chipotle Mexican Grill, US\$2123.54 (03 Jul 2023); The Cheesecake Factory Inc, US\$35.35 (03 Jul 2023); Levi Strauss & Co, US\$14.40 (03 Jul 2023); Apple Inc., US\$192.46 (03 Jul 2023); Colgate-Palmolive, US\$77.14 (03 Jul 2023); Boston Beer Company Inc, US\$309.54 (03 Jul 2023); Conagra Brands Inc., US\$34.09 (03 Jul 2023); Essential Utilities Inc, US\$40.32 (03 Jul 2023); McDonald's, US\$294.84 (03 Jul 2023); Shiseido, ¥6436 (05 Jul 2023); Solvay, €101.45 (04 Jul 2023); Kimberly-Clark Corp, US\$137.48 (03 Jul 2023); Procter & Gamble, US\$152.50 (03 Jul 2023); Shake Shack Inc., US\$78.10 (03 Jul 2023); Clariant, CHF12.96 (04 Jul 2023); Ryohin Keikaku, ¥1401 (05 Jul 2023); Fast Retailing, ¥35700 (05 Jul 2023); Johnson Controls International plc, US\$67.67 (03 Jul 2023); Ibiden, ¥8424 (05 Jul 2023); PepsiCo Inc, US\$185.60 (03 Jul 2023); Lanxess AG, €28.15 (04 Jul 2023); American States Water Co, US\$87.58 (03 Jul 2023); Daikin Industries, ¥30720 (05 Jul 2023); Waste Management Inc, US\$171.40 (03 Jul 2023); OPAL Fuels Inc., US\$7.61 (03 Jul 2023); Constellation Brands Inc, US\$247.47 (03 Jul 2023); Corteva Inc, US\$58.00 (03 Jul 2023); California Water Service Group, US\$51.88 (03 Jul 2023); KOSE, ¥13975 (05 Jul 2023); Molson Coors Beverage Company, US\$66.61 (03 Jul 2023); ABOUT YOU Holdings SE, €4.94 (04 Jul 2023); DuPont de Nemours Inc, US\$71.57 (03 Jul 2023); On Holding AG, US\$33.16 (03 Jul 2023); Clean Harbors Inc, US\$163.17 (03 Jul 2023); Next, 6974p (04 Jul 2023); The Wendy's Co, US\$21.80 (03 Jul 2023); Asos, 369p (04 Jul 2023); Amorepacific, Won96200 (05 Jul 2023); Pentair Plc, US\$63.97 (03 Jul 2023); Yum! Brands, US\$137.27 (03 Jul 2023); Arkema, €87.84 (04 Jul 2023); Sony Group, ¥13310 (05 Jul 2023); American Water Works Co, US\$143.97 (03 Jul 2023); Republic Services Inc, US\$151.40 (03 Jul 2023); The Estée Lauder Companies Inc, US\$198.00 (03 Jul 2023); Shinko Electric Industries, ¥6200 (05 Jul 2023); Mondelez International Inc, US\$73.51 (03 Jul 2023); Deckers Outdoor Corp, US\$531.46 (03 Jul 2023); Inditex SA, €35.29 (04 Jul 2023); Dow Inc, US\$53.78 (03 Jul 2023); The Clorox Company, US\$160.34 (03 Jul 2023); Inner Mongolia Yili Industrial, Rmb28.77 (05 Jul 2023); SJW Group, US\$70.37 (03 Jul 2023); Renesas Electronics, ¥2835 (05 Jul 2023); Nordstrom Inc, US\$20.63 (03 Jul 2023); Wacker Chemie, €128.60 (04 Jul 2023); YETI Holdings Inc, US\$38.85 (03 Jul 2023); The Hershey Company, US\$251.73 (03 Jul 2023); Tokyo Electron, ¥21315 (05 Jul 2023); Mitsui Chemicals, ¥4260 (05 Jul 2023); Starbucks, US\$99.15 (03 Jul 2023); H & M, SKr185.30 (04 Jul 2023); Signet Jewelers, US\$66.96 (03 Jul 2023); Texas Roadhouse Inc, US\$113.26 (03 Jul 2023); Brown-Forman Corp, US\$66.82 (03 Jul 2023); Nitori Holdings, ¥15930 (05 Jul 2023); Source: UBS. All prices as of local market close.

Company profile and fee and risk statement under the Japanese Financial Instruments & Exchange Law

Company Name etc: UBS Securities Japan Co., Ltd., Financial Instruments & Exchange Firm, Kanto Local Financial Bureau (Kinsho) No.2633

Associated Memberships: Japan Securities Dealers' Association, the Financial Futures Association of Japan, and Type II Financial Instruments Firms Association

UBS Securities Japan Co., Ltd. will receive a brokerage fee based on an individual contract and no standard upper limit or calculating method. For the trading of domestic stocks, consumption tax is added to the fee. For the trading of foreign stock, fee on the foreign stock exchange or foreign tax may be charged in addition to the domestic fee and tax. Those amounts may vary depending on the jurisdiction. There is a risk that a loss may occur due to a change in the price of the stock in the case of trading stocks, and that a loss may occur due to the exchange rate in the case of trading foreign stocks. There is a risk that a loss may occur due to a change in the price or performance of the properties in the portfolio in the case of trading REITs.

UBS Securities Japan Co., Ltd. will only receive the purchasing amounts for trading unlisted bonds (JGBs, municipals, government guaranteed bonds, corporate bonds) when UBS Securities Japan Co., Ltd. is the counterparty. There is a risk that a loss may occur due to a change in the price of the bond caused by the fluctuations in the interest rates, and that a loss may occur due to the exchange rate in the case of trading foreign bonds.

For the detailed information of commissions and risks associated with individual financial instrument transactions, please carefully read the documents provided prior to the execution of the contracts or other materials for customers, etc. before executing any transaction. If you need any clarification, please consult with our sales person in charge.

The Disclaimer relevant to Global Wealth Management clients follows the Global Disclaimer.

UBS Global Research Disclaimer

This document has been prepared by UBS Securities Japan Co., Ltd., an affiliate of UBS AG. UBS AG, its subsidiaries, branches and affiliates, including Credit Suisse AG and its subsidiaries, branches and affiliates are referred to herein as "UBS".

Any opinions expressed in this document may change without notice and are only current as of the date of publication. Different areas, groups, and personnel within UBS may produce and distribute separate research products independently of each other. For example, research publications from **UBS CIO** are produced by UBS Global Wealth Management. **UBS Global Research** is produced by UBS Investment Bank. **Credit Suisse Global CIO Office Research** is produced by Credit Suisse Wealth Management. **Credit Suisse Securities Research** is produced by Credit Suisse operating under its Securities Research function within the Investment Banking Division. Research methodologies and rating systems of each separate research organization may differ, for example, in terms of investment recommendations, investment horizon, model assumptions, and valuation methods. As a consequence, except for certain economic forecasts (for which UBS CIO and UBS Global Research may collaborate), investment recommendations, ratings, price targets, and valuations provided by each of the separate research organizations may be different, or inconsistent. You should refer to each relevant research product for the details as to their methodologies and rating system. Not all clients may have access to all products from every organization. Each research product is subject to the policies and procedures of the organization that produces it.

This document is provided solely to recipients who are expressly authorized by UBS to receive it. If you are not so authorized you must immediately destroy the document.

UBS Global Research is provided to our clients through UBS Neo, and in certain instances, UBS.com and any other system or distribution method specifically identified in one or more communications distributed through UBS Neo or UBS.com (each a system) as an approved means for distributing UBS Global Research. It may also be made available through third party vendors and distributed by UBS and/or third parties via e-mail or alternative electronic means.

All UBS Global Research is available on UBS Neo. Please contact your UBS sales representative if you wish to discuss your access to UBS Neo. Where UBS Global Research refers to "UBS Evidence Lab Inside" or has made use of data provided by UBS Evidence Lab and you would like to access that data please contact your UBS sales representative. UBS Evidence Lab data is available on UBS Neo. The level and types of services provided by UBS Global Research and UBS Evidence Lab to a client may vary depending upon various factors such as a client's individual preferences as to the frequency and manner of receiving communications, a client's risk profile and investment focus and perspective (e.g., market wide, sector specific, long-term, short-term, etc.), the size and scope of the overall client relationship with UBS Global Research and UBS Evidence Lab and legal and regulatory constraints.

When you receive UBS Global Research through a system, your access and/or use of such UBS Global Research is subject to this UBS Global Research Disclaimer and to the UBS Neo Platform Use Agreement (the "Neo Terms") together with any other relevant terms of use governing the applicable System.

When you receive UBS Global Research via a third party vendor, e-mail or other electronic means, you agree that use shall be subject to this UBS Global Research Disclaimer, the Neo Terms and where applicable the UBS Investment Bank terms of business (<https://www.ubs.com/global/en/investment-bank/regulatory.html>) and to UBS's Terms of Use/Disclaimer (<https://www.ubs.com/global/en/legalinfo2/disclaimer.html>). In addition, you consent to UBS processing your personal data and using cookies in accordance with our Privacy Statement (<https://www.ubs.com/global/en/legalinfo2/privacy.html>) and cookie notice (<https://www.ubs.com/global/en/legal/privacy/users.html>).

If you receive UBS Global Research, whether through a System or by any other means, you agree that you shall not copy, revise, amend, create a derivative work, provide to any third party, or in any way commercially exploit any UBS research provided via UBS Global Research or otherwise, and that you shall not extract data from any research or estimates provided to you via UBS Global Research or otherwise, without the prior written consent of UBS.

In certain circumstances (including for example, if you are an academic or a member of the media) you may receive UBS Global Research otherwise than in the capacity of a client of UBS and you understand and agree that (i) the UBS Global Research is provided to you for information purposes only; (ii) for the purposes of receiving it you are not intended to be and will not be treated as a "client" of UBS for any legal or regulatory purpose; (iii) the UBS Global Research must not be relied on or acted upon for any purpose; and (iv) such content is subject to the relevant disclaimers that follow.

This document is for distribution only as may be permitted by law. It is not directed to, or intended for distribution to or use by, any person or entity who is a citizen or resident of or located in any locality, state, country or other jurisdiction where such distribution, publication, availability or use would be contrary to law or regulation or would subject UBS to any registration or licensing requirement within such jurisdiction.

This document is a general communication and is educational in nature; it is not an advertisement nor is it a solicitation or an offer to buy or sell any financial instruments or to participate in any particular trading strategy. Nothing in this document constitutes a representation that any investment strategy or recommendation is suitable or appropriate to an investor's individual circumstances or otherwise constitutes a personal recommendation. By providing this document, none of UBS or its representatives has any responsibility or authority to provide or have provided investment advice in a fiduciary capacity or otherwise. Investments involve risks, and investors should exercise prudence and their own judgment in making their investment decisions. None of UBS or its representatives is suggesting that the recipient or any other person take a specific course of action or any action at all. The recipient should carefully read this document in its entirety and not draw inferences or conclusions from the rating alone. By receiving this document, the recipient acknowledges and agrees with the intended purpose described above and further disclaims any expectation or belief that the information constitutes investment advice to the recipient or otherwise purports to meet the investment objectives of the recipient. The financial instruments described in the document may not be eligible for sale in all jurisdictions or to certain categories of investors.

Options, structured derivative products and futures (including OTC derivatives) are not suitable for all investors. Trading in these instruments is considered risky and may be appropriate only for sophisticated investors. Prior to buying or selling an option, and for the complete risks relating to options, you must receive a copy of "The Characteristics and Risks of Standardized Options." You may read the document at <https://www.theocc.com/publications/risks/riskchap1.jsp> or ask your salesperson for a copy. Various theoretical explanations of the risks associated with these instruments have been published. Supporting documentation for any claims, comparisons, recommendations, statistics or other technical data will be supplied upon request. Past performance is not necessarily indicative of future results. Transaction costs may be significant in option strategies calling for multiple purchases and sales of options, such as spreads and straddles. Because of the importance of tax considerations to many options transactions, the investor considering options should consult with his/her tax advisor as to how taxes affect the outcome of contemplated options transactions.

Mortgage and asset-backed securities may involve a high degree of risk and may be highly volatile in response to fluctuations in interest rates or other market conditions. Foreign currency rates of exchange may adversely affect the value, price or income of any security or related instrument referred to in the document. For investment advice, trade execution or other enquiries, clients should contact their local sales representative.

The value of any investment or income may go down as well as up, and investors may not get back the full (or any) amount invested. Past performance is not necessarily a guide to future performance. Neither UBS nor any of its directors, employees or agents accepts any liability for any loss (including investment loss) or damage arising out of the use of all or any of the Information.

Prior to making any investment or financial decisions, any recipient of this document or the information should take steps to understand the risk and return of the investment and seek individualized advice from his or her personal financial, legal, tax and other professional advisors that takes into account all the particular facts and circumstances of his or her investment objectives.

Any prices stated in this document are for information purposes only and do not represent valuations for individual securities or other financial instruments. There is no representation that any transaction can or could have been effected at those prices, and any prices do not necessarily reflect UBS's internal books and records or theoretical model-based valuations and may be based on certain assumptions. Different assumptions by UBS or any other source may yield substantially different results.

No representation or warranty, either expressed or implied, is provided in relation to the accuracy, completeness or reliability of the information contained in any materials to which this document relates (the "Information"), except with respect to Information concerning UBS. The Information is not intended to be a complete statement or summary of the securities, markets or developments referred to in the document. UBS does not undertake to update or keep current the Information. Any statements contained in this report attributed to a third party represent UBS's interpretation of the data, information and/or opinions provided by that third party either publicly or through a subscription service, and such use and interpretation have not been reviewed by the third party. In no circumstances may this document or any of the Information (including any forecast, value, index or other calculated amount ("Values")) be used for any of the following purposes:

- (i) valuation or accounting purposes;
- (ii) to determine the amounts due or payable, the price or the value of any financial instrument or financial contract; or
- (iii) to measure the performance of any financial instrument including, without limitation, for the purpose of tracking the return or performance of any Value or of defining the asset allocation of portfolio or of computing performance fees.

By receiving this document and the Information you will be deemed to represent and warrant to UBS that you will not use this document or any of the Information for any of the above purposes or otherwise rely upon this document or any of the Information.

UBS has policies and procedures, which include, without limitation, independence policies and permanent information barriers, that are intended, and upon which UBS relies, to manage potential conflicts of interest and control the flow of information within divisions of UBS and among its subsidiaries, branches and affiliates. For further information on the ways in which UBS Global Research manages conflicts and maintains independence of its research products, historical performance information and certain additional disclosures concerning UBS Global Research recommendations, please visit <https://www.ubs.com/disclosures>.

UBS Global Research will initiate, update and cease coverage solely at the discretion of UBS Global Research Management, which will also have sole discretion on the timing and frequency of any published research product. The analysis contained in this document is based on numerous assumptions. All material information in relation to published research reports, such as valuation methodology, risk statements, underlying assumptions (including sensitivity analysis of those assumptions), ratings history etc. as required by the Market Abuse Regulation, can be found on UBS Neo. Different assumptions could result in materially different results.

The analyst(s) responsible for the preparation of this document may interact with trading desk personnel, sales personnel and other parties for the purpose of gathering, applying and interpreting market information. UBS relies on information barriers to control the flow of information contained in one or more areas within UBS into other areas, units, groups or affiliates of UBS. The compensation of the analyst who prepared this document is determined exclusively by UBS Global Research management and senior management (not including investment banking). Analyst compensation is not based on investment banking revenues; however, compensation may relate to the revenues of UBS and/or its divisions as a whole, of which investment banking, sales and trading are a part, and UBS as a whole.

For financial instruments admitted to trading on an EU regulated market: UBS (excluding UBS Securities LLC) acts as a market maker or liquidity provider (in accordance with the interpretation of these terms under English law or, if not carried out by UBS in the UK the law of the relevant jurisdiction in which UBS determines it carries out the activity) in the financial instruments of the issuer save that where the activity of liquidity provider is carried out in accordance with the definition given to it by the laws and regulations of any other EU jurisdictions, such information is separately disclosed in this document. For financial instruments admitted to trading on a non-EU regulated market: UBS may act as a market maker save that where this activity is carried out in the US in accordance with the definition given to it by the relevant laws and regulations, such activity will be specifically disclosed in this document. UBS may have issued a warrant the value of which is based on one or more of the financial instruments referred to in the document. UBS and its affiliates and employees may have long or short positions, trade as principal and buy and sell in instruments or derivatives identified herein; such transactions or positions may be inconsistent with the opinions expressed in this document.

Within the past 12 months UBS may have received or provided investment services and activities or ancillary services as per MiFID II which may have given rise to a payment or promise of a payment in relation to these services from or to this company.

United Kingdom: This material is distributed by UBS AG, London Branch to persons who are eligible counterparties or professional clients. UBS AG, London Branch is authorised by the Prudential Regulation Authority and subject to regulation by the Financial Conduct Authority and limited regulation by the Prudential Regulation Authority. **Europe:** Except as otherwise specified herein, these materials are distributed by UBS Europe SE, a subsidiary of UBS AG, to persons who are eligible counterparties or professional clients (as detailed in the Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin) Rules and according to MiFID) and are only available to such persons. The information does not apply to, and should not be relied upon by, retail clients. UBS Europe SE is authorised by the European Central Bank (ECB) and regulated by the BaFin and the ECB. **Germany, Luxembourg, the Netherlands, Belgium and Ireland:** Where an analyst of UBS Europe SE has contributed to this document, the document is also deemed to have been prepared by UBS Europe SE. In all cases it is distributed by UBS Europe SE and UBS AG, London Branch. **Turkey:** Distributed by UBS AG, London Branch. No information in this document is provided for the purpose of offering, marketing and sale by any means of any capital market instruments and services in the Republic of Turkey. Therefore, this document may not be considered as an offer made or to be made to residents of the Republic of Turkey. UBS AG, London Branch is not licensed by the Turkish Capital Market Board under the provisions of the Capital Market Law (Law No. 6362). Accordingly, neither this document nor any other offering material related to the instruments/services may be utilized in connection with providing any capital market services to persons within the Republic of Turkey without the prior approval of the Capital Market Board. However, according to article 15 (d) (ii) of the Decree No. 32, there is no restriction on the purchase or sale of the securities abroad by residents of the Republic of Turkey. **Poland:** Distributed by UBS Europe SE (spółka z ograniczoną odpowiedzialnością) Oddział w Polsce regulated by the Polish Financial Supervision Authority. Where an analyst of UBS Europe SE (spółka z ograniczoną odpowiedzialnością) Oddział w Polsce has contributed to this document, the document is also deemed to have been prepared by UBS Europe SE (spółka z ograniczoną odpowiedzialnością) Oddział w Polsce. **Russia:** Prepared and distributed by UBS Bank (OOO). Should not be construed as an individual Investment Recommendation for the purpose of the Russian Law - Federal Law #39-FZ ON THE SECURITIES MARKET Articles 6.1-6.2. **Switzerland:** Distributed by UBS AG to persons who are institutional investors only. UBS AG is regulated by the Swiss Financial Market Supervisory Authority (FINMA). **Italy:** Prepared by UBS Europe SE and distributed by UBS Europe SE and UBS Europe SE, Italy Branch. Where an analyst of UBS Europe SE, Italy Branch has contributed to this document, the document is also deemed to have been prepared by UBS Europe SE, Italy Branch. **France:** Prepared by UBS Europe SE and distributed by UBS Europe SE and UBS Europe SE, France Branch. Where an analyst of UBS Europe SE, France Branch has contributed to this document, the document is also deemed to have been prepared by UBS Europe SE, France Branch. **Spain:** Prepared by UBS Europe SE and distributed by UBS Europe SE and UBS Europe SE, Spain Branch. Where an analyst of UBS Europe SE, Spain Branch has contributed to this document, the document is also deemed to have been prepared by UBS Europe SE, Spain Branch. **Sweden:** Prepared by UBS Europe SE and distributed by UBS Europe SE and UBS Europe SE, Sweden Branch. Where an analyst of UBS Europe SE, Sweden Branch has contributed to this document, the document is also deemed to have been prepared by UBS Europe SE, Sweden Branch. **South Africa:** Distributed by UBS South Africa (Pty) Limited (Registration No. 1995/011140/07), an authorised user of the JSE and an authorised Financial Services Provider (FSP 7328). **Saudi Arabia:** This document has been issued by UBS AG (and/or any of its subsidiaries, branches or affiliates), a public company limited by shares, incorporated in Switzerland with its registered offices at Aeschenvorstadt 1, CH-4051 Basel and Bahnhofstrasse 45, CH-8001 Zurich. This publication has been approved by UBS Saudi Arabia (a subsidiary of UBS AG), a Saudi closed joint stock company incorporated in the Kingdom of Saudi Arabia under commercial register number 1010257812 having its registered office at Tatweer Towers, P.O. Box 75724, Riyadh 11588, Kingdom of Saudi Arabia. UBS Saudi Arabia is authorized and regulated by the Capital Market Authority to conduct securities business under license number 08113-37. **UAE / Dubai:** The information distributed by UBS AG Dubai Branch is only intended for Professional Clients and/or Market Counterparties, as classified under the DFSA rulebook. No other person should act upon this material/communication. The information is not for further distribution within the United Arab Emirates. UBS AG Dubai Branch is regulated by the DFSA in the DIFC. UBS Investment Bank is not licensed to provide banking services in the UAE by the Central Bank of the UAE, nor is it licensed by the UAE Securities and Commodities Authority. **Israel:** This Material is distributed by UBS AG, London Branch. UBS Securities Israel Ltd is a licensed Investment Marketer that is supervised by the Israel Securities Authority (ISA). UBS AG, London Branch and its affiliates incorporated outside Israel are not licensed under the Israeli Advisory Law. UBS may engage among others in issuance of Financial Assets or in distribution of Financial Assets of other issuers for fees or other benefits. UBS AG, London Branch and its affiliates may prefer various Financial Assets to which they have or may have an Affiliation (as such term is defined under the Israeli Advisory Law). Nothing in this Material should be considered as investment advice under the Israeli Advisory Law. This Material is being issued only to and/or is directed only at persons who are Eligible Clients within the meaning of the Israeli Advisory Law, and this Material must not be furnished to, relied on or acted upon by any other persons. **United States:** Distributed to US persons by either UBS Securities LLC or by UBS Financial Services Inc., subsidiaries of UBS AG; or by a group, subsidiary or affiliate of UBS AG that is not registered as a US broker-dealer (a 'non-US affiliate') to major US institutional investors only. UBS Securities LLC or UBS Financial Services Inc. accepts responsibility for the content of a report prepared by another non-US affiliate when distributed to US persons by UBS Securities LLC or UBS Financial Services Inc. All transactions by a US person in the securities mentioned in this report must be effected through UBS Securities LLC or UBS Financial Services Inc., and not through a non-US affiliate. UBS Securities LLC is not acting as a municipal advisor to any municipal entity or obligated person within the meaning of Section 15B of the Securities Exchange Act (the "Municipal Advisor Rule"), and the opinions or views contained herein are not intended to be, and do not constitute, advice within the meaning of the Municipal Advisor Rule. **Canada:** Distributed by UBS Securities Canada Inc., a registered investment dealer in Canada and a Member-Canadian Investor Protection Fund, or by another affiliate of UBS AG that is registered to conduct business in Canada or is otherwise exempt from registration. **Brazil:** Except as otherwise specified herein, this Material is prepared by UBS Brasil Corretora de Câmbio, Títulos e Valores Mobiliários S.A. (UBS Brasil CCTVM) to persons who are eligible investors residing in Brazil, which are considered to be Professional Investors (Investidores Profissionais), as designated by the applicable regulation, mainly the CVM Resolution No. 30 from the 11th of May 2021 (determines the duty to verify the suitability of products, services and transactions with regards to the client's profile). UBS Brasil CCTVM is a subsidiary of UBS BB Servicos de Assessoria Financeira e Participacoes S.A. ("UBS BB"). UBS BB is an association between UBS AG and Banco do Brasil (through its subsidiary BB – Banco de Investimentos S.A.), of which UBS AG is the majority owner and which provides investment banking services and coverage in Brazil, Argentina, Chile, Paraguay, Peru and Uruguay. **Hong Kong:** Distributed by UBS Securities Asia Limited. Please contact local licensed persons of UBS Securities Asia Limited in respect of any matters arising from, or in connection with, the analysis or document. **Singapore:** Distributed by UBS Securities Pte. Ltd. [Co. Reg. No.: 198500648C] or UBS AG, Singapore Branch. Please contact UBS Securities Pte. Ltd., an exempt financial adviser under the Singapore Financial Advisers Act (Cap. 110); or UBS AG, Singapore Branch, an exempt financial adviser under the Singapore Financial Advisers Act (Cap. 110) and a wholesale bank licensed under the Singapore Banking Act (Cap. 19) regulated by the Monetary Authority of Singapore, in respect of any matters arising from, or in connection with, the analysis or document. The recipients of this document represent and warrant that they are accredited and institutional investors as defined in the Securities and Futures Act (Cap. 289). **Japan:** Distributed by UBS Securities Japan Co., Ltd. to professional investors (except as otherwise permitted). Where this report has been prepared by UBS Securities Japan Co., Ltd., UBS Securities Japan Co., Ltd. is the author, publisher and distributor of the report. Distributed by UBS AG, Tokyo Branch to Professional Investors (except as otherwise permitted) in relation to foreign exchange and other banking businesses when relevant. **Australia:** Clients of UBS AG: Distributed by UBS AG (ABN 47 088 129 613 and holder of Australian Financial Services License No. 231087). Clients of UBS Securities Australia Ltd: Distributed by UBS Securities Australia Ltd (ABN 62 008 586 481 and holder of Australian Financial Services License No. 231098). This document contains general information and/or general advice only and does not constitute personal financial product advice. As such, the information in this document has been prepared without taking into account any investor's objectives, financial situation or needs, and investors should, before acting on the information, consider the appropriateness of the information, having regard to their objectives, financial situation and needs. If the information contained in this document relates to the acquisition, or potential acquisition of a particular financial product by a 'Retail' client as defined by section 761G of the Corporations Act 2001 where a Product Disclosure Statement

would be required, the retail client should obtain and consider the Product Disclosure Statement relating to the product before making any decision about whether to acquire the product. **New Zealand:** Distributed by UBS New Zealand Ltd. UBS New Zealand Ltd is not a registered bank in New Zealand. You are being provided with this publication or material because you have indicated to UBS that you are a "wholesale client" within the meaning of section 5C of the Financial Advisers Act 2008 of New Zealand (Permitted Client). This publication or material is not intended for clients who are not Permitted Clients (non-permitted Clients). If you are a non-permitted Client you must not rely on this publication or material. If despite this warning you nevertheless rely on this publication or material, you hereby (i) acknowledge that you may not rely on the content of this publication or material and that any recommendations or opinions in such this publication or material are not made or provided to you, and (ii) to the maximum extent permitted by law (a) indemnify UBS and its associates or related entities (and their respective Directors, officers, agents and Advisors) (each a "Relevant Person") for any loss, damage, liability or claim any of them may incur or suffer as a result of, or in connection with, your unauthorised reliance on this publication or material and (b) waive any rights or remedies you may have against any Relevant Person for (or in respect of) any loss, damage, liability or claim you may incur or suffer as a result of, or in connection with, your unauthorised reliance on this publication or material. **Korea:** Distributed in Korea by UBS Securities Pte. Ltd., Seoul Branch. This report may have been edited or contributed to from time to time by affiliates of UBS Securities Pte. Ltd., Seoul Branch. This material is intended for professional/institutional clients only and not for distribution to any retail clients. **Malaysia:** This material is authorized to be distributed in Malaysia by UBS Securities Malaysia Sdn. Bhd (Capital Markets Services License No.: CMSL/A0063/2007). This material is intended for professional/institutional clients only and not for distribution to any retail clients. **India:** Distributed by UBS Securities India Private Ltd. (Corporate Identity Number U67120MH1996PTC097299) 3/F, 2 North Avenue, Maker Maxity, Bandra Kurla Complex, Bandra (East), Mumbai (India) 400051. Phone: +912261556000. It provides brokerage services bearing SEBI Registration Number: INZ000259830; and Research Analyst services bearing SEBI Registration Number: INH000001204. Name of Compliance Officer Mr. Parameshwaran Shivaramakrishnan, Phone : +912261556151, Email : [REDACTED]@ubs.com, Name of Grievance Officer Parameshwaran Shivaramakrishnan, Phone : +912261556151, Email : [REDACTED]@ubs.com. Registration granted by SEBI, and certification from NISM in no way guarantee performance of the intermediary or provide any assurance of returns to investors. UBS may have debt holdings or positions in the subject Indian company/companies. UBS may have financial interests (e.g. loan/derivative products, rights to or interests in investments, etc.) in the subject Indian company / companies from time to time. Within the past 12 months, UBS may have received compensation for non-investment banking securities-related services and/or non-securities services from the subject Indian company/companies. The subject company/companies may have been a client/clients of UBS during the 12 months preceding the date of distribution of the research report with respect to investment banking and/or non-investment banking securities-related services and/or non-securities services. With regard to information on associates, please refer to the Annual Report at: https://www.ubs.com/global/en/about_ubs/investor_relations/annualreporting.html **Taiwan:** Except as otherwise specified herein, this material may not be distributed in Taiwan. Information and material on securities/instruments that are traded in a Taiwan organized exchange is deemed to be issued and distributed by UBS Securities Pte. LTD., Taipei Branch, which is licensed and regulated by Taiwan Financial Supervisory Commission. Save for securities/instruments that are traded in a Taiwan organized exchange, this material should not constitute "recommendation" to clients or recipients in Taiwan for the covered companies or any companies mentioned in this document. No portion of the document may be reproduced or quoted by the press or any other person without authorisation from UBS. **Indonesia:** This report is being distributed by PT UBS Sekuritas Indonesia and is delivered by its licensed employee(s), including marketing/sales person, to its client. PT UBS Sekuritas Indonesia, having its registered office at Sequis Tower Level 22 unit 22-1, Jl.Jend. Sudirman, kav.71, SCBD lot 11B, Jakarta 12190. Indonesia, is a subsidiary company of UBS AG and licensed under Capital Market Law no. 8 year 1995, a holder of broker-dealer and underwriter licenses issued by the Capital Market and Financial Institution Supervisory Agency (now Otoritas Jasa Keuangan/OJK). PT UBS Sekuritas Indonesia is also a member of Indonesia Stock Exchange and supervised by Otoritas Jasa Keuangan (OJK). Neither this report nor any copy hereof may be distributed in Indonesia or to any Indonesian citizens except in compliance with applicable Indonesian capital market laws and regulations. This report is not an offer of securities in Indonesia and may not be distributed within the territory of the Republic of Indonesia or to Indonesian citizens in circumstance which constitutes an offering within the meaning of Indonesian capital market laws and regulations.

The disclosures contained in research documents produced by UBS AG, London Branch or UBS Europe SE shall be governed by and construed in accordance with English law.

UBS specifically prohibits the redistribution of this document in whole or in part without the written permission of UBS and in any event UBS accepts no liability whatsoever for any redistribution of this document or its contents or the actions of third parties in this respect. Images may depict objects or elements that are protected by third party copyright, trademarks and other intellectual property rights. © UBS 2023. The key symbol and UBS are among the registered and unregistered trademarks of UBS. All rights reserved.

Global Wealth Management Disclaimer

You receive this document in your capacity as a client of UBS Global Wealth Management. This publication has been distributed to you by UBS Switzerland AG (regulated by FINMA in Switzerland) or its affiliates ("**UBS**") with whom you have a banking relationship with. The full name of the distributing affiliate and its competent authority can be found in the country-specific disclaimer at the end of this document.

The date and time of the first dissemination of this publication is the same as the date and time of its publication.

Risk information:

You agree that you shall not copy, revise, amend, create a derivative work, provide to any third party, or in any way commercially exploit any UBS research, and that you shall not extract data from any research or estimates, without the prior written consent of UBS.

This document is for distribution only as may be permitted by law. It is not directed to, or intended for distribution to or use by, any person or entity who is a citizen or resident of or located in any locality, state, country or other jurisdiction where such distribution, publication, availability or use would be contrary to law or regulation or would subject UBS to any registration or licensing requirement within such jurisdiction.

This document is **for your information only**; it is not an advertisement nor is it a solicitation or an offer to buy or sell any financial instruments or to participate in any particular trading strategy. Nothing in this document constitutes a representation that any investment strategy or recommendation is suitable or appropriate to an investor's individual circumstances or otherwise constitutes a personal recommendation. By providing this document, none of UBS or its representatives has any responsibility or authority to provide or have provided investment advice in a fiduciary capacity or otherwise. Investments involve risks, and investors should exercise prudence and their own judgment in making their investment decisions. None of UBS or its representatives is suggesting that the recipient or any other person take a specific course of action or any action at all. By receiving this document, the recipient acknowledges and agrees with the intended purpose described above and further disclaims any expectation or belief that the information constitutes investment advice to the recipient or otherwise purports to meet the investment objectives of the recipient. The financial instruments described in the document may not be eligible for sale in all jurisdictions or to certain categories of investors.

Options, derivative products and futures are not suitable for all investors, and trading in these instruments is considered risky. Mortgage and asset-backed securities may involve a high degree of risk and may be highly volatile in response to fluctuations in interest rates or other market conditions. Foreign currency rates of exchange may adversely affect the value, price or income of any security or related instrument referred to in the document. For investment advice, trade execution or other enquiries, clients should contact their local sales representative.

The value of any investment or income may go down as well as up, and investors may not get back the full (or any) amount invested. Past performance is not necessarily a guide to future performance. Neither UBS nor any of its directors, employees or agents accepts any liability for any loss (including investment loss) or damage arising out of the use of all or any of the information (as defined below).

Prior to making any investment or financial decisions, any recipient of this document or the information should take steps to understand the risk and return of the investment and seek individualized advice from his or her personal financial, legal, tax and other professional advisors that takes into account all the particular facts and circumstances of his or her investment objectives.

Any prices stated in this document are for information purposes only and do not represent valuations for individual securities or other financial instruments. There is no representation that any transaction can or could have been effected at those prices, and any prices do not necessarily reflect UBS's internal books and records or theoretical model-based valuations and may be based on certain assumptions. Different assumptions by UBS or any other source may yield substantially different results.

No representation or warranty, either expressed or implied, is provided in relation to the accuracy, completeness or reliability of the information contained in any materials to which this document relates (the "Information"), except with respect to Information concerning UBS. The Information is not intended to be a complete statement or summary of the securities, markets or developments referred to in the document. UBS does not undertake to update or keep current the Information. Any opinions expressed in this document may change without notice and may differ or be contrary to opinions expressed by other business areas or groups, personnel or other representative of UBS. Any statements contained in this report attributed to a third party represent UBS's interpretation of the data, information and/or opinions provided by that third party either publicly or through a subscription service, and such use and interpretation have not been reviewed by the third party. In no circumstances may this document or any of the Information (including any forecast, value, index or other calculated amount ("Values")) be used for any of the following purposes: (i) valuation or accounting purposes; (ii) to determine the amounts due or payable, the price or the value of any financial instrument or financial contract; or (iii) to measure the performance of any financial instrument including, without limitation, for the purpose of tracking the return or performance of any Value or of defining the asset allocation of portfolio or of computing performance fees.

By receiving this document and the Information you will be deemed to represent and warrant to UBS that you will not use this document or any of the Information for any of the above purposes or otherwise rely upon this document or any of the Information.

UBS has policies and procedures, which include, without limitation, independence policies and permanent information barriers, that are intended, and upon which UBS relies, to manage potential conflicts of interest and control the flow of information within divisions of UBS (including between Global Wealth Management and UBS Global Research) and among its subsidiaries, branches and affiliates. For further information on the ways in which UBS manages conflicts and maintains independence of its research products, historical performance information and certain additional disclosures concerning UBS research recommendations, please visit <https://www.ubs.com/research-methodology>.

Research will initiate, update and cease coverage solely at the discretion of research management, which will also have sole discretion on the timing and frequency of any published research product. The analysis contained in this document is based on numerous assumptions. Different assumptions could result in materially different results.

The analyst(s) responsible for the preparation of this document may interact with trading desk personnel, sales personnel and other parties for the purpose of gathering, applying and interpreting market information. UBS relies on information barriers to control the flow of information contained in one or more areas within UBS into other areas, units, groups or affiliates of UBS. The compensation of the analyst who prepared this document is determined exclusively by research management and senior management (not including investment banking). Analyst compensation is not based on investment banking revenues; however, compensation may relate to the revenues of UBS and/or its divisions as a whole, of which investment banking, sales and trading are a part, and UBS's subsidiaries, branches and affiliates as a whole.

For financial instruments admitted to trading on an EU regulated market: UBS AG, its affiliates or subsidiaries (excluding UBS Securities LLC) acts as a market maker or liquidity provider (in accordance with the interpretation of these terms in the UK) in the financial instruments of the issuer save that where the activity of liquidity provider is carried out in accordance with the definition given to it by the laws and regulations of any other EU jurisdictions, such information is separately disclosed in this document. For financial instruments admitted to trading on a non-EU regulated market: UBS may act as a market maker save that where this activity is carried out in the US in accordance with the definition given to it by the relevant laws and regulations, such activity will be specifically disclosed in this document. UBS may have issued a warrant the value of which is based on one or more of the financial instruments referred to in the document. UBS and its affiliates and employees may have long or short positions, trade as principal and buy and sell in instruments or derivatives identified herein; such transactions or positions may be inconsistent with the opinions expressed in this document.

Options and futures are not suitable for all investors, and trading in these instruments is considered risky and may be appropriate only for sophisticated investors. Prior to buying or selling an option, and for the complete risks relating to options, you must receive a copy of "Characteristics and Risks of Standardized Options". You may read the document at <https://www.theocc.com/about/publications/character-risks.jsp> or ask your financial advisor for a copy.

Investing in structured investments involves significant risks. For a detailed discussion of the risks involved in investing in any particular structured investment, you must read the relevant offering materials for that investment. Structured investments are unsecured obligations of a particular issuer with returns linked to the performance of an underlying asset. Depending on the terms of the investment, investors could lose all or a substantial portion of their investment based on the performance of the underlying asset. Investors could also lose their entire investment if the issuer becomes insolvent. UBS does not guarantee in any way the obligations or the financial condition of any issuer or the accuracy of any financial information provided by any issuer. Structured investments are not traditional investments and investing in a structured investment is not equivalent to investing directly in the underlying asset. Structured investments may have limited or no liquidity, and investors should be prepared to hold their investment to maturity. The return of structured investments may be limited by a maximum gain, participation rate or other feature. Structured investments may include call features and, if a structured investment is called early, investors would not earn any further return and may not be able to reinvest in similar investments with similar terms. Structured investments include costs and fees which are generally embedded in the price of the investment. The tax treatment of a structured investment may be complex and may differ from a direct investment in the underlying asset. UBS and its employees do not provide tax advice. Investors should consult their own tax advisor about their own tax situation before investing in any securities.

Important Information About Sustainable Investing Strategies: Sustainable investing strategies aim to consider and incorporate environmental, social and governance (ESG) factors into investment process and portfolio construction. Strategies across geographies and styles approach ESG analysis and incorporate the findings in a variety of ways. Incorporating ESG factors or Sustainable Investing considerations may inhibit the portfolio manager's ability to participate in certain investment opportunities that otherwise would be consistent with its investment objective and other principal investment strategies. The returns on a portfolio consisting primarily of sustainable investments may be lower or higher than portfolios where ESG factors, exclusions, or other sustainability issues are not considered by the portfolio manager, and the investment opportunities available to such portfolios may differ. Companies may not necessarily meet high performance standards on all aspects of ESG or sustainable investing issues; there is also no guarantee that any company will meet expectations in connection with corporate responsibility, sustainability, and/or impact performance.

Within the past 12 months UBS Switzerland AG, its affiliates or subsidiaries may have received or provided investment services and activities or ancillary services as per MiFID II which may have given rise to a payment or promise of a payment in relation to these services from or to this company.

If you require detailed information on disclosures of interest or conflict of interest as required by Market Abuse Regulation please contact the mailbox [@ubs.com](mailto:ubs@ubs.com). Please note that e-mail communication is unsecured.

External Asset Managers / External Financial Consultants: In case this research or publication is provided to an External Asset Manager or an External Financial Consultant, UBS expressly prohibits that it is redistributed by the External Asset Manager or the External Financial Consultant and is made available to their clients and/or third parties.

Bahrain: UBS is a Swiss bank not licensed, supervised or regulated in Bahrain by the Central Bank of Bahrain to undertake banking or investment business activities in Bahrain. Therefore, prospects/clients do not have any protection under local banking and investment services laws and regulations. **Brazil:** This report is only intended for Brazilian residents who are directly purchasing or selling securities in the Brazil capital market through a local authorized institution. **Canada:** The information contained herein is not, and under no circumstances is to be construed as, a prospectus, an advertisement, a public offering, an offer to sell securities described herein, solicitation of an offer to buy securities described herein, in Canada or any province or territory thereof. Any offer or sale of the securities described herein in Canada will be made only under an exemption from the requirements to file a prospectus with the relevant Canadian securities regulators and only by a dealer properly registered under applicable securities laws or, alternatively, pursuant to an exemption from the dealer registration requirement in the relevant province or territory of Canada in which such offer or sale is made. Under no circumstances is the information contained herein to be construed as investment advice in any province or territory of Canada and is not tailored to the needs of the recipient. To the extent that the information contained herein references securities of an issuer incorporated, formed or created under the laws of Canada or a province or territory of Canada, any trades in such securities must be conducted through a dealer registered in Canada or, alternatively, pursuant to a dealer registration exemption. No securities commission or similar regulatory authority in Canada has reviewed or in any way passed upon these materials, the information contained herein or the merits of the securities described herein and any representation to the contrary is an offence. In Canada, this publication is distributed by UBS Investment Management Canada Inc. **China:** This report and any offering material such as term sheet, research report, other product or service documentation or any other information (the "Material") sent with this report was done so as a result of a request received by UBS from you and/or persons entitled to make the request on your behalf. Should you have received the material erroneously, UBS asks that you kindly delete it and inform UBS immediately. This report is prepared by UBS Switzerland AG or its offshore subsidiary or affiliate (collectively as "UBS Offshore"). UBS Offshore is an entity incorporated out of China and is not licensed, supervised or regulated in China to carry out banking or securities business. The recipient should not contact the analysts or UBS Offshore which produced this report for advice as they are not licensed to provide securities investment advice in China. UBS Investment Bank (including Research) has its own wholly independent research and views which at times may vary from the views of UBS Global Wealth Management. The recipient should not use this document or otherwise rely on any of the information contained in this report in making investment decisions and UBS takes no responsibility in this regard. **Czech Republic:** UBS is not a licensed bank in the Czech Republic and thus is not allowed to provide regulated banking or investment services in the Czech Republic. This communication and/or material is distributed for marketing purposes and constitutes a "Commercial Message" under the laws of Czech Republic in relation to banking and/or investment services. Please notify UBS if you do not wish to receive any further correspondence. **Denmark:** This publication is not intended to constitute a public offer under Danish law. It is distributed only for information purposes to clients of UBS Europe SE, Denmark Branch, filial af UBS Europe SE, with place of business at Sankt Annæ Plads 13, 1250 Copenhagen, Denmark, registered with the Danish Commerce and Companies Agency, under No. 38 17 24 33. UBS Europe SE, Denmark Branch, filial af UBS Europe SE is subject to the joint supervision of the European Central Bank, the German Central Bank (Deutsche Bundesbank), the German Federal Financial Services Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, "BaFin"), as well as of the Danish Financial Supervisory Authority (Finanstilsynet), to which this publication has not been submitted for approval. UBS Europe SE is a credit institution constituted under German law in the form of a Societas Europaea, duly authorized by BaFin. **Egypt:** Securities or other investment products are not being offered or sold by UBS to the public in Egypt and they have not been and will not be registered with the Egyptian Financial Regulatory Authority (FRA). **France:** This publication is not intended to constitute a public offer under French law, it does not constitute a personal recommendation as it is distributed only for information purposes to clients of UBS (France) S.A., French "société anonyme" with share capital of € 132.975.556, at 69 boulevard Haussmann F-75008 Paris, registered with the "Registre du Commerce et des Sociétés" of Paris under N° B 421 255 670. UBS (France) S.A. is a provider of investment services duly authorized according to the terms of the "Code monétaire et financier", regulated by French banking and financial authorities as the "Autorité de contrôle prudentiel et de résolution" and "Autorité des marchés financiers", to which this publication has not been submitted for approval. **Germany:** This publication is not intended to constitute a public offer under German law. It is distributed only for information purposes to clients of UBS Europe SE, Germany, with place of business at Bockenheimer Landstrasse 2-4, 60306 Frankfurt am Main. UBS Europe SE is a credit institution constituted under German law in the form of a Societas Europaea, duly authorized by the German Federal Financial Services Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, "BaFin") and supervised jointly by the European Central Bank, the German Central Bank (Deutsche Bundesbank) and BaFin, to which this publication has not been submitted for approval. **Hong Kong SAR:** This publication is distributed to clients of UBS AG Hong Kong Branch by UBS AG Hong Kong Branch, a licensed bank under the Hong Kong Banking Ordinance and a registered institution under the Securities and Futures Ordinance. UBS AG Hong Kong Branch is incorporated in Switzerland with limited liability. **India:** Distributed by UBS Securities India Private Ltd. (Corporate Identity Number U67120MH1996PTC097299) 2/F, 2 North Avenue, Maker Maxity, Bandra Kurla Complex, Bandra (East), Mumbai (India) 400051. Phone: +912261556000. It provides brokerage services bearing SEBI Registration Number INZ000259830; merchant banking services bearing SEBI Registration Number:

INM000010809 and Research Analyst services bearing SEBI Registration Number: INH000001204. UBS AG, its affiliates or subsidiaries may have debt holdings or positions in the subject Indian company/companies. UBS AG, its affiliates or subsidiaries may have financial interests (e.g. like loan/derivative products, rights to or interests in investments, etc.) in the subject Indian company/companies from time to time. Within the past 12 months, UBS AG, its affiliates or subsidiaries may have received compensation for non-investment banking securities-related services and/or non-securities services from the subject Indian company/companies. The subject company/companies may have been a client/clients of UBS AG, its affiliates or subsidiaries during the 12 months preceding the date of distribution of the research report with respect to investment banking and/or non-investment banking securities-related services and/or non-securities services. With regard to information on associates, please refer to the Annual Report at: https://www.ubs.com/global/en/about_ubs/investor_relations/annualreporting.html.

Indonesia: This communication and any offering material term sheet, research report, other product or service documentation or any other information (the "Material") sent with this communication was done so as a result of a request received by UBS from you and/or persons entitled to make the request on your behalf. Should you have received the Material erroneously, UBS asks that you kindly delete the e-mail and inform UBS immediately. The Material, where provided, was provided for your information only and is not to be further distributed without the consent of UBS. None of the Material has been registered or filed under the prevailing laws and with any financial or regulatory authority in your jurisdiction. The Material may not have been approved, disapproved, endorsed, registered or filed with any financial or regulatory authority in your jurisdiction. UBS has not, by virtue of the Material, made available, issued any invitation to subscribe for or to purchase any investment (including securities or products or futures contracts). The Material is neither an offer nor a solicitation to enter into any transaction or contract (including futures contracts) nor is it an offer to buy or to sell any securities or products. The relevant investments will be subject to restrictions and obligations on transfer as set forth in the Material, and by receiving the Material you undertake to comply fully with such restrictions and obligations. You should carefully study and ensure that you understand and exercise due care and discretion in considering your investment objective, risk appetite and personal circumstances against the risk of the investment. You are advised to seek independent professional advice in case of doubt. Any and all advice provided on and/or trades executed by UBS pursuant to the Material will only have been provided upon your specific request or executed upon your specific instructions, as the case may be, and may be deemed as such by UBS and you.

Israel: UBS is a premier global financial firm offering wealth management, asset management and investment banking services from its headquarters in Switzerland and its operations in over 50 countries worldwide to individual, corporate and institutional investors. In Israel, UBS Switzerland AG is registered as Foreign Dealer in cooperation with UBS Wealth Management Israel Ltd., a wholly owned UBS subsidiary. UBS Wealth Management Israel Ltd. is an Investment Marketing licensee which engages in Investment Marketing and is regulated by the Israel Securities Authority. This publication is intended for information only and is not intended as an offer to buy or solicitation of an offer. Furthermore, this publication is not intended as an investment advice. No action has been, or will be, taken in Israel that would permit an offering of the product(s) mentioned in this document or a distribution of this document to the public in Israel. In particular, this document has not been reviewed or approved by the Israeli Securities Authority. The product(s) mentioned in this document is/are being offered to a limited number of sophisticated investors who qualify as one of the investors listed in the first supplement to the Israeli Securities Law, 5728-1968. This document may not be reproduced or used for any other purpose, nor be furnished to any other person other than those to whom copies have been sent. Anyone who purchases the product(s) mentioned herein shall do so for its own benefit and for its own account and not with the aim or intention of distributing or offering the product(s) to other parties. Anyone who purchases the product(s) shall do so in accordance with its own understanding and discretion and after it has received any relevant financial, legal, business, tax or other advice or opinion required by it in connection with such purchase(s). The word "advice" and/or any of its equivalent terms shall be read and construed in conjunction with the definition of the term "investment marketing" as defined under the Israeli Regulation of Investment Advice, Investment Marketing and Portfolio Management Law. The Swiss laws and regulations require a number of mandatory disclosures to be made in independent financial research reports or recommendations. Pursuant to the Swiss Financial Market Infrastructure Act and the Financial Market Infrastructure Ordinance-FINMA, banks must disclose the percentage of voting rights they hold in companies being researched, if these holdings are equal to or exceed the statutory thresholds. In addition, the Directives on the Independence of Financial Research, issued by the Swiss Bankers Association, mandate a number of disclosures, including the disclosure of potential conflicts of interest, the participation within previous 12 months in any securities issues on behalf of the company being researched, as well as the fact that remuneration paid to the financial analysts is based generally upon the performance of (i) the new issues department or investment banking; or (ii) securities trading performance (including proprietary trading) or sales.

Italy: This publication is not intended to constitute a public offer under Italian law. It is distributed only for information purposes to clients of UBS Europe SE, Succursale Italia, with place of business at Via del Vecchio Politecnico, 3-20121 Milano. UBS Europe SE, Succursale Italia is subject to the joint supervision of the European Central Bank, the German Central Bank (Deutsche Bundesbank), the German Federal Financial Services Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, "BaFin"), as well as of the Bank of Italy (Banca d'Italia) and the Italian Financial Markets Supervisory Authority (CONSOB - Commissione Nazionale per le Società e la Borsa), to which this publication has not been submitted for approval. UBS Europe SE is a credit institution constituted under German law in the form of a Societas Europaea, duly authorized by BaFin.

Jersey: UBS AG, Jersey Branch, is regulated and authorized by the Jersey Financial Services Commission for the conduct of banking, funds and investment business. Where services are provided from outside Jersey, they will not be covered by the Jersey regulatory regime. UBS AG, Jersey Branch is a branch of UBS AG a public company limited by shares, incorporated in Switzerland whose registered offices are at Aeschenvorstadt 1, CH-4051 Basel and Bahnhofstrasse 45, CH 8001 Zurich. UBS AG, Jersey Branch's principal place of business is 1, IFC Jersey, St Helier, Jersey, JE2 3BX.

Luxembourg: This publication is not intended to constitute a public offer under Luxembourg law. It is distributed only for information purposes to clients of UBS Europe SE, Luxembourg Branch ("UBS Luxembourg"), R.C.S. Luxembourg n° B209123, with registered office at 33A, Avenue J. F. Kennedy, L-1855 Luxembourg. UBS Europe SE is a credit institution constituted under German law in the form of a Societas Europaea (HRB n° 107046), with registered office at Bockenheimer Landstrasse 2-4, D-60306 Frankfurt am Main, Germany, duly authorized by the German Federal Financial Services Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, "BaFin") and subject to the joint prudential supervision of BaFin, the European Central Bank and the central bank of Germany (Deutsche Bundesbank). UBS Luxembourg is furthermore supervised by the Luxembourg prudential supervisory authority (Commission de Surveillance du Secteur Financier), in its role as host member state authority. This publication has not been submitted for approval to any public supervisory authority.

Malaysia: This communication and any offering material term sheet, research report, other product or service documentation or any other information (the "Material") sent with this communication was done so as a result of a request received by UBS from you and/or persons entitled to make the request on your behalf. Should you have received the Material erroneously, UBS asks that you kindly delete the e-mail and inform UBS immediately. The Material, where provided, was provided for your information only and is not to be further distributed in whole or in part in or into your jurisdiction without the consent of UBS. The Material may not have been reviewed, approved, disapproved, endorsed, registered or filed with any financial or regulatory authority in your jurisdiction. UBS has not, by virtue of the Material, made available, issued any invitation to subscribe for or to purchase any investment (including securities or derivatives products). The Material is neither an offer nor a solicitation to enter into any transaction or contract (including future contracts) nor is it an offer to buy or to sell any securities or derivatives products. The relevant investments will be subject to restrictions and obligations on transfer as set forth in the Material, and by receiving the Material you undertake to comply fully with such restrictions and obligations. You should carefully study and ensure that you understand and exercise due care and discretion in considering your investment objective, risk appetite and personal circumstances against the risk of the investment. You are advised to seek independent professional advice in case of doubt. Any and all advice provided on and/or trades executed by UBS pursuant to the Material will only have been provided upon your specific request or executed upon your specific instructions, as the case may be, and may be deemed as such by UBS and you.

Mexico: This information is distributed by UBS Asesores México, S.A. de C.V. ("UBS Asesores"), an affiliate of UBS Switzerland AG, incorporated as a non-independent investment advisor under the Mexican regulation due to the relation with a Foreign Bank. UBS Asesores is registered under number 30060-001-(14115)-21/06/2016 and subject to the supervision of the Mexican Banking and Securities Commission ("CNBV") exclusively regarding the rendering of (i) portfolio management services, (ii) securities investment advisory services, analysis and issuance of individual investment recommendations, and (iii) anti-money laundering and terrorism financing matters. This UBS publication or any material related thereto is addressed only to Sophisticated or Institutional Investors located in Mexico. Research reports only reflect the views of the analysts responsible for the report. The compensation of the analyst(s) who prepared this report is determined exclusively by research management and senior management of any entity of UBS Group to which such analyst(s) render(s) services.

Monaco: This document is not intended to constitute a public offering or a comparable solicitation under the Principality of Monaco laws, but might be made available for information purposes to clients of UBS (Monaco) S.A., a regulated bank having its registered office at 2 avenue de Grande Bretagne 98000 Monaco operating under a banking license granted by the "Autorité de Contrôle Prudentiel et de Résolution" (ACPR) and the Monegasque government which authorizes the provision of banking services in Monaco. UBS (Monaco) S.A. is also licensed by the "Commission de Contrôle des Activités Financières" (CCAF) to provide investment services in Monaco. The latter has not approved this publication.

Nigeria: The investment products mentioned in this material are not being offered or sold by UBS to the public in Nigeria and they have not been submitted for approval nor registered with the Securities and Exchange Commission of Nigeria. If you are interested in products of this nature, please let us know. The investment products mentioned in this material are not being directed to, and are not being made available for subscription by any persons within Nigeria other than the selected investors to whom the offer materials have been addressed as a private sale or domestic concern within the exemption and meaning of Section 69(2) of the Investments and Securities Act, 2007 (ISA). This material has been provided to you at your specific unsolicited request and for your information only.

Philippines: This communication was done so as a result of a request received by UBS from you and/or persons entitled to make the request on your behalf. Should you have received the Material erroneously, UBS asks that you kindly delete the e-mail and inform UBS immediately. The Material, where provided, was provided for your information only and is not to be further distributed in whole or in part in or into your jurisdiction without the consent of UBS. The Material may not have been reviewed, approved, disapproved, endorsed, registered or filed with any financial or regulatory authority in your jurisdiction. UBS has not, by virtue of the Material, made available, issued any invitation to subscribe for or to purchase any investment (including securities or derivatives products). The Material is neither an offer nor a solicitation to enter into any transaction or contract (including future contracts) nor is it an offer to buy or to sell any securities or derivatives products. The relevant investments will be subject to restrictions and obligations on transfer as set forth in the Material, and by receiving the Material you undertake to comply fully with such restrictions and obligations. You should carefully study and ensure that you understand and exercise due care and discretion in considering your investment objective, risk appetite and personal circumstances against the risk of the investment. You are advised to seek independent professional advice in case of doubt. Any and all advice provided on and/or trades executed by UBS pursuant to the Material will only have been provided upon your specific request or executed upon your specific instructions, as the case may be, and may be deemed as such by UBS and you.

Portugal: UBS Switzerland AG is not licensed to conduct banking and financial activities in Portugal nor is UBS Switzerland AG supervised by the Portuguese regulators (Bank of Portugal "Banco de Portugal" and Portuguese Securities Exchange Commission "Comissão do Mercado de Valores Mobiliários").

Qatar: UBS Qatar LLC is authorized by the Qatar Financial Centre Regulatory Authority, with QFC no. 01169, and has its registered office at 14th Floor, Burj Alfardan Tower, Building 157, Street No. 301, Area No. 69, Al Majdumi, Lusail, Qatar. UBS

Qatar LLC neither offers any brokerage services nor executes any order with, for or on behalf of its clients. A client order will have to be placed with, and executed by, UBS Switzerland AG in Switzerland or an affiliate of UBS Switzerland AG, that is domiciled outside Qatar. It is in the sole discretion of UBS Switzerland AG in Switzerland or its affiliate to accept or reject an order and UBS Qatar LLC does not have authority to provide a confirmation in this respect. UBS Qatar LLC may however communicate payment orders and investment instructions to UBS Switzerland AG in Switzerland for receipt, acceptance and execution. UBS Qatar LLC is not authorized to act for and on behalf of UBS Switzerland AG or an affiliate of UBS Switzerland AG. This document and any attachments hereto are intended for eligible counterparties and business customers only.

Russia: This document or information contained therein is for information purposes only and constitutes neither a public nor a private offering, is not an invitation to make offers, to sell, exchange or otherwise transfer any financial instruments in the Russian Federation to or for the benefit of any Russian person or entity and does not constitute an advertisement or offering of securities in the Russian Federation within the meaning of Russian securities laws. The information contained herein is not an "individual investment recommendation" as defined in Federal Law of 22 April 1996 No 39-FZ "On Securities Market" (as amended) and the financial instruments and operations specified herein may not be suitable for your investment profile or your investment goals or expectations. The determination of whether or not such financial instruments and operations are in your interests or are suitable for your investment goals, investment horizon or the acceptable risk level is your responsibility. We assume no liability for any losses connected with making any such operations or investing into any such financial instruments and we do not recommend to use such information as the only source of information for making an investment decision. **Saudi Arabia:** UBS Saudi Arabia is authorised and regulated by the Capital Market Authority to conduct securities business under licence number 08113-37. **Singapore:** Clients of UBS AG Singapore branch are asked to please contact UBS AG Singapore branch, an exempt financial adviser under the Singapore Financial Advisers Act (Cap. 110) and a wholesale bank licensed under the Singapore Banking Act (Cap. 19) regulated by the Monetary Authority of Singapore, in respect of any matters arising from, or in connection with, the analysis or report. UBS AG is incorporated in Switzerland with limited liability. UBS AG has a branch registered in Singapore (UEN S98FC5560C). This communication and any offering material term sheet, research report, other product or service documentation or any other information (the "Material") sent with this communication was done so as a result of a request received by UBS from you and/or persons entitled to make the request on your behalf. Should you have received the Material erroneously, UBS asks that you kindly delete the e-mail and inform UBS immediately. The Material, where provided, was provided for your information only and is not to be further distributed in whole or in part in or into your jurisdiction without the consent of UBS. The Material may not have been reviewed, approved, disapproved or endorsed by any financial or regulatory authority in your jurisdiction. UBS has not, by virtue of the Material, made available, issued any invitation to subscribe for or to purchase any investment (including securities or products or futures contracts). The Material is neither an offer nor a solicitation to enter into any transaction or contract (including future contracts) nor is it an offer to buy or to sell any securities or products. The relevant investments will be subject to restrictions and obligations on transfer as set forth in the Material, and by receiving the Material you undertake to comply fully with such restrictions and obligations. You should carefully study and ensure that you understand and exercise due care and discretion in considering your investment objective, risk appetite and personal circumstances against the risk of the investment. You are advised to seek independent professional advice in case of doubt. Any and all advice provided on and/or trades executed by UBS pursuant to the Material will only have been provided upon your specific request or executed upon your specific instructions, as the case may be, and may be deemed as such by UBS and you. **Sweden:** This publication is not intended to constitute a public offer under Swedish law. It is distributed only for information purposes to clients of UBS Europe SE, Sweden Bankfilial, with place of business at Regeringsgatan 38, 11153 Stockholm, Sweden, registered with the Swedish Companies Registration Office under Reg. No 516406-1011. UBS Europe SE, Sweden Bankfilial is subject to the joint supervision of the European Central Bank, the German Central Bank (Deutsche Bundesbank), the German Federal Financial Services Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, "BaFin"), as well as of the Swedish supervisory authority (Finansinspektionen), to which this publication has not been submitted for approval. UBS Europe SE is a credit institution constituted under German law in the form of a Societas Europaea, duly authorized by BaFin. **Taiwan:** This material is provided by UBS AG, Taipei Branch in accordance with laws of Taiwan, in agreement with or at the request of clients/prospects. **Thailand:** This communication and any offering material, term sheet, research report, other product or service documentation or any other information (the "Material") sent with this communication were done so as a result of a request received by UBS from you and/or persons entitled to make the request on your behalf. Should you have received the Material erroneously, UBS asks that you kindly delete the e-mail and inform UBS immediately. The Material, where provided, was provided for your information only and is not to be further distributed in whole or in part in or into your jurisdiction without the consent of UBS. The Material may not have been reviewed, approved, disapproved, endorsed, registered or filed with any financial or regulatory authority in your jurisdiction. UBS has not, by virtue of the Material, made available, issued any invitation to subscribe for or to purchase any investment (including securities or derivatives products). The Material is neither an offer nor a solicitation to enter into any transaction or contract (including future contracts) nor is it an offer to buy or to sell any securities or derivatives products. The relevant investments will be subject to restrictions and obligations on transfer as set forth in the Material, and by receiving the Material you undertake to comply fully with such restrictions and obligations. You should carefully study and ensure that you understand and exercise due care and discretion in considering your investment objective, risk appetite and personal circumstances against the risk of the investment. You are advised to seek independent professional advice in case of doubt. Any and all advice provided and/or trades executed by UBS pursuant to the Material will only have been provided upon your specific request or executed upon your specific instructions, as the case may be, and may be deemed as such by UBS and you. **Turkey:** The information in this document is not provided for the purpose of offering, marketing or sale of any capital market instrument or service in the Republic of Turkey. Therefore, this document may not be considered as an offer made, or to be made, to residents of the Republic of Turkey in the Republic of Turkey. UBS Switzerland AG is not licensed by the Turkish Capital Market Board (the CMB) under the provisions of the Capital Market Law (Law No. 6362). Accordingly, neither this document nor any other offering material related to the instrument/service may be utilized in connection with providing any capital market services to persons within the Republic of Turkey without the prior approval of the CMB. However, according to article 15 (d) (ii) of the Decree No. 32 residents of the Republic of Turkey are allowed to purchase or sell the financial instruments traded in financial markets outside of the Republic of Turkey. Further to this, pursuant to article 9 of the Communiqué on Principles Regarding Investment Services, Activities and Ancillary Services No. III-37.1, investment services provided abroad to residents of the Republic of Turkey based on their own initiative are not restricted. **United Arab Emirates (UAE):** UBS is not a financial institution licensed in the UAE by the Central Bank of the UAE nor by the Emirates' Securities and Commodities Authority and does not undertake banking activities in the UAE. UBS AG Dubai Branch is licensed by the DFSA in the DIFC. This document is provided for your information only and does not constitute financial advice. **United Kingdom:** This document is issued by UBS Wealth Management, a division of UBS AG which is authorised and regulated by the Financial Market Supervisory Authority in Switzerland. In the United Kingdom, UBS AG is authorised by the Prudential Regulation Authority and is subject to regulation by the Financial Conduct Authority and limited regulation by the Prudential Regulation Authority. Details about the extent of regulation by the Prudential Regulation Authority are available from us on request. A member of the London Stock Exchange. This publication is distributed to retail clients of UBS Wealth Management. **Ukraine:** UBS is not registered and licensed as a bank/financial institution under Ukrainian legislation and does not provide banking and other financial services in Ukraine. UBS has not made, and will not make, any offer of the mentioned products to the public in Ukraine. No action has been taken to authorize an offer of the mentioned products to the public in Ukraine and the distribution of this document shall not constitute financial services for the purposes of the Law of Ukraine "On Financial Services and State Regulation of Financial Services Markets" dated 12 July 2001. Any offer of the mentioned products shall not constitute an investment advice, public offer, circulation, transfer, safekeeping, holding or custody of securities in the territory of Ukraine. Accordingly, nothing in this document or any other document, information or communication related to the mentioned products shall be interpreted as containing an offer, a public offer or invitation to offer or to a public offer, or solicitation of securities in the territory of Ukraine or investment advice under Ukrainian law. Electronic communication must not be considered as an offer to enter into an electronic agreement or other electronic instrument within the meaning of the Law of Ukraine "On Electronic Commerce" dated 3 September 2015. This document is strictly for private use by its holder and may not be passed on to third parties or otherwise publicly distributed. **USA:** Distributed to US persons by UBS Financial Services Inc. or UBS Securities LLC, subsidiaries of UBS AG. UBS Switzerland AG, UBS Europe SE, UBS Bank, S.A., UBS Brasil Administradora de Valores Mobiliários Ltda., UBS Asesores México, S.A. de C.V., UBS SuMi TRUST Wealth Management Co., Ltd., UBS Wealth Management Israel Ltd. and UBS Menkul Degerler AS are affiliates of UBS AG. **UBS Financial Services Inc. accepts responsibility for the content of a report prepared by a non-US affiliate when it distributes reports to US persons. All transactions by a US person in the securities mentioned in this report should be effected through a US-registered broker dealer affiliated with UBS, and not through a non-US affiliate. The contents of this report have not been and will not be approved by any securities or investment authority in the United States or elsewhere. UBS Financial Services Inc. is not acting as a municipal advisor to any municipal entity or obligated person within the meaning of Section 15B of the Securities Exchange Act (the "Municipal Advisor Rule") and the opinions or views contained herein are not intended to be, and do not constitute, advice within the meaning of the Municipal Advisor Rule.**

© UBS 2023. The key symbol and UBS are among the registered and unregistered trademarks of UBS. All rights reserved.

