ChemSec – submission to public consultation:

Restriction of Per- and polyfluoroalkyl substances (PFAS)

ChemSec strongly supports a broad group restriction of Per- and polyfluoroalkyl substances (PFAS), in line with the commitment from the EU Commission in the Chemicals Strategy for Sustainability.

Our support is founded on the following main points, all of which are also well described in the dossier:

1. **We are facing an urgent, global PFAS crisis,** where the levels in the environment, in our drinking water, in our food, and our own bodies are increasing. In many cases, these levels are already high enough to cause severe problems for the environment and human health. As long as PFAS continues to be produced and used, these levels will keep rising.
2. The urgent situation is due especially to the **extreme persistence**, which is the common property of all PFAS chemicals. This is also why the whole group, including polymers and F-gases, needs to be restricted.
3. While the PFAS-producing industry has had knowledge about the problematic properties of these substances for decades, the public has been kept in the dark. Instead, **the high costs following PFAS exposure** due to contaminated soil and water, remediation costs, drinking water purification, and health care **have been borne by society**.
4. For the majority of PFAS uses, **safer alternatives are available**, and much innovation is ongoing in the area. Alternatives are continuously developed and improved.
5. We can have a green transition while restricting the use of PFAS. The alternatives are becoming available. **No transition can be called green if it contributes to the PFAS crisis.**
6. **Many companies have already acted to phase-out PFAS** or are working intensively to do so. They have invested in innovation and rely on a ban on PFAS for these investments to pay off.
7. **Financial investors are calling for an end to PFAS production**, especially considering the increasing costs for PFAS clean-up.
8. We need to act now to **end the increasing PFAS exposure**. The cost and suffering borne by society are disproportionate to the potential benefits a continuous use of PFAS might have.

PFAS production and use has led to a planetary crisis

The detrimental effects of PFAS have been known by industry for many decades and despite this the production and the emissions have continued.[1, 2] As a result, we have today over 17,000 contaminated sites in the EU.[3] Every citizen[4,5], including our teenagers[6], have high PFAS concentrations in the blood.[7] Even the rainwater in the most remote areas of the globe exceed safe drinking water levels for PFAS, why scientists conclude that we have overstepped the planetary boundaries for PFAS.[7]

The enormous costs from this pollution are born by society

The societal costs connected to PFAS, including costs for health care and environmental remediation of water and soil, are staggering. In a conservative estimation they were estimated to €16 trillion annually.[8] Other estimations of the social costs show similar shocking numbers.[9,10] These costs are born by society and by individuals. These are unavoidable costs, for example, there is a need to treat large parts of the European drinking water to reach safe levels.[11,12]

In addition, the levels of PFAS found in our food sources, such as livestock, fish, and shrimp, has been found to be above safe levels.[13,14] While being a severe problem for human health, the increasing awareness, and the upcoming implementation of the new PFAS limit values also put a high burden on farmers, fishermen and other small and family-owned businesses within the food sector. Some examples of this are the Dutch shrimp fishers[15] and Danish egg producers.[16]

The extreme persistence of every PFAS presents an unacceptable risk

The PFAS restriction targets the persistent PFAS compounds, and rightly so, since the extreme persistence is the main and common problematic property for all substances in this diverse group. The extreme persistence leads to increasing concentrations in the environment and in humans, as long as use and production continues. Over time this results in levels affecting biological systems and we are already in some cases above those levels. Persistence alone can be considered an unacceptable risk, as has earlier been shown for the restriction of microplastics.[17,18,19]

Besides the persistent properties, common to all PFAS under the restriction, these substances have a range of additional hazardous properties, well described in the dossier. Most of them are being either bioaccumulate or mobile. Other commonly observed effects are endocrine disrupting effects, reprotoxic effects, effects on the immune system and on the liver as well as different types of carcinogenicity.[20] The combination of persistence with these additional hazardous properties further adds to the concern.

A group restriction is necessary to end regrettable substitution

The PFAS group has become a poster-child example of so called “regrettable substitution”. This means that industry, whenever one PFAS chemical has come under regulatory scrutiny or supply chain pressure, has shifted to a structurally similar PFAS compound and thus escaped regulation for yet some time. Examples of this are the substitution of PFOA/PFOS with GEN-X as process aids for production of fluoropolymers and the substitution HFOs with HFCs as refrigerants.[21,22]

There are estimates of the total number of PFAS chemicals ranging from a few thousands to several millions of substances. This consequently gives endless possibilities for substituting one PFAS with another. Obviously, the only way to efficiently regulate PFAS is as a group of substances. For this purpose, the use of a definition instead of a list of substances is very valuable, as it will cover also potential PFAS substances, not yet being marketed or even invented. This will help steer innovation away from PFAS compounds, to ensure that future

solutions are free of not yet invented PFAS, and provides predictability in the value chain. We support the use of the OECD definition for this purpose.[23]

The polymeric structure of fluoropolymers does not justify an exclusion. The production, use and waste of fluoropolymers are largely contributing to the current vast exposure to PFAS. The entire life-cycle from production and use to waste is very problematic, while the magnitude of it is not yet entirely understood.[26] The scientific evidence show similar problematic properties as for other PFAS and fluoropolymers are found in human blood[5] and can be transported across cell membranes.[27]In addition, the formation of micro- and nano plastics from fluoropolymers has been shown by identification of PTFE in different biota.[28,29]

Several claims from fluorochemical industry are misleading or inaccurate

The restriction proposal dossier clearly shows that, industrial uses contribute significantly to the total use and emissions of PFAS. Even though the fluorochemical industry, especially in the EU, have invested in technologies to limit the emissions of PFAS from the production sites, emissions from these sites are still substantial. It is evident that the legislation in place to limit emissions from industrial sites is far from adequate and claims that emissions of PFAS from production can be controlled are not supported by the finding of the dossier submitter. Claims that emissions can be controlled in the waste phase are even further from the truth.[30]

Also, the claim that fluoropolymers should be considered as “polymers of low concern” is incorrect. This is a claim based on limited studies only considering the use-phase. Therefore, the OECD definition for “polymers of low concern” cannot be applied.[31]

Claims that fluoropolymers are “essential for society” or “necessary for the green transition” are inaccurate[8,32]. The bulk volumes of fluoropolymers are not produced for products that could be considered critical for society or for the green transition.[8,33] In the limited cases where alternatives are not yet available, which have been identified in the dossier, the proposed derogation times allow for innovation.

Many of the most severe and catastrophic cases of PFAS pollution of human blood, food and the environment are results from fluoropolymer production. People living close to these production sites, e.g., in Veneto, Antwerp and Dordrecht have been exposed and suffered for decades and will be for years to come.[34] The same companies that are responsible for this are the ones now putting enormous amounts of lobbying money into saying that fluoropolymers are not only safe but also essential for health and the society. For people in these regions as well as for all citizens of Europe, a ban on PFAS excluding fluoropolymers is nothing but a huge political failure.

F-gases are contributing with high emissions of PFAS to the environment

The F-gases that fall under the structural definition of the restriction proposal are persistent PFAS or degrade to persistent PFAS like trifluoroacetic acid (TFA). They are therefore, and should maintain to be, covered by this restriction. The specific regulation for F-gases[35] focuses on global warming potential and does not cover all relevant persistent F-gases, why this PFAS restriction fills an important gap.

F-gases are a significant contributor to PFAS emissions[20] while there is already an abundance of alternatives that can be used instead[36]. Concentrations of persistent and mobile TFA have increased multiple times in groundwater and drinking water the last decades following on the substitution of HFOs with HFCs. TFA has also been found to accumulate in the human food chain.[37,38]

PFAS alternatives are available, including for applications for the green transition

The availability of safer alternatives to PFAS is, for many uses, large and displays a variety of different solutions. For the largest emitters, TULAC and F-gases/refrigerants there are already today well-established alternatives which have since long been on the market.[36,39]

Legislation, and even the anticipation of regulation, is a major driver for innovation[40] and already now the plethora of alternatives is growing fast, including for the uses considered to be "difficult".[41] Development of PFAS alternatives have in several cases shown to be less cumbersome than expected, for example the development of new surfactants for semiconductor manufacturing by the Transene company, where the alternative proved to have similar performance, and was less costly.[42] Cost was also not an issue for COOP Denmark when phasing out PFAS in food packaging applications.[43]

Even where PFAS was considered to be irreplaceable, for example in fuel cells or electrolyzers, companies like Ionomr,[44] Ionosys,[45] Cellfion[46] and others[47,48] showed that innovation makes this possible, indicating that creativity and innovation is the way forward, and that unsubstantiated claims of "impossibility" must be considered subjective business protection rather than the objective truth.

Some new technologies have been developed, not for the sake of replacing PFAS per see, but when it has been realized that PFAS is not performing well enough for the application. This was the case when Nanoramic[48] started developing electronic devices for space applications. Interestingly this also show that PFAS is not, as is often said, the only and best material to achieve sufficient durability and inertness.

It is important to remember that only a small part of the PFAS uses are attributed to uses that can be critical,[8] and the derogated uses in the restriction proposal have been given sufficient time to develop alternatives for uses as well. In addition, it is worth pointing out that, for many uses, the transition times are very long, up to 13.5 years and will give enough time to find alternative solutions also for "difficult uses". We do not see a need to further prolong the already long transition times.

In line with the proposal, we support the aim of a total phase out after the transition times. The dossier submitters have done a thorough work to identify alternatives, been transparent on the strength of evidence and open to input several times along the process. It is important that further additions to these proposed derogations are supported by scientific evidence and not unsubstantiated claims.

In summary, alternative solutions exist already for most applications, and the transition times will allow for innovation of alternatives for the remaining and critical uses.[49] However, this will not happen if this restriction is too much delayed or transition times are too long or even time unlimited. Predictability is key to a sound process and it is therefore crucial to

keep up the momentum and the message to industry that PFAS need to be phased out to. Also, the many companies already ahead of the curve having invested in solutions need this restriction for their investments and efforts to pay-off. The green transition is dependent on the move towards safer chemicals in products, ensuring a further step in the direction of a green and sustainable future Europe.

Many companies have phased-out PFAS and support a ban

The PFAS movement is a network of more than 100 consumer-facing companies from many different sectors, that support a broad ban on PFAS as a group.[50] The members of the PFAS movement include companies that have already substituted, or have never used PFAS, but also companies that currently use PFAS, but have an outspoken ambition to phase them out.

In February 2023 ChemSec conducted a survey among these companies.[51] The results showed that all companies were convinced that a strict regulation of PFAS is important. In addition, half of the companies in the survey had already initiated the phase-out of PFAS, showing the importance of regulatory predictability. These companies have already taken steps towards increased sustainability, and regulation must now follow, or these important steps will have been done in vain.

The members of the PFAS movement are generally companies that are not used to engaging in the political processes or have a large budget for lobbying work. Nevertheless, it is important that these voices are heard, and their efforts acknowledged.

The members of the PFAS Movement are:

Abacus
ACO
Advansor
Aequor Inc.
Alligo
Apotea
Armadillo Merino
ARTILECT
AxFood AB
Bacher Work Wear
Bagaren & Kocken
Ballingslöv
BAMA Group
Base Of Sweden
Beautycounter
Bergans
BESTSELLER (Only, Vero Moda, Jack&Jones)
BionicProtect
Björk and Berries
Björn Axén
BK
Blue Diamond

Blue Loop Originals
Blåbær Production AS
Brunngård AB
Cellbes
Cervera
CGS
CHEVALIER
Clas Ohlson
Combekk
Coop Denmark
Coop Sverige
Craft of Scandinavia
Dafo
Didriksons
Elis Textil Service AB
Ellos Group (Ellos, Jotex, Stayhard, Homeroom)
Elvine
Eureau
Fjällräven
Fristads
GreenChef
GreenLife
GreenPan
Greyhound Chromatography & Allied Chemicals
H&M
Heirol
Houdini
Housegard
ICA
ICANIWILL
Icebug
IDUN Minerals
Inditex
INTERSPORT
iPinium
Isadora
JeckyBeng
KappAhl
KEEN Footwear
KID / Hemtex
Kingfisher
Klättermusen
Kronans Apotek
Kälte Eckert GmbH
Lacoste
Levi Strauss & Co.
Lindex

LYKO
Mammut
Marshall Headphones
MAX Burgers
Menigo Foodservice AB
Merten & Stock
NA-KD
Naturepedic
New Balance
NilsonGroup
Nilörn
Nudie Jeans
One For All
OrganoClick
Peak Performance
Pictura
Presto
Procurator
Ralph Lauren
Reflex
Revolutionrace AB
RITUALS
Royal van Kampen & Begeer
Runex
Rusta
Salming Sports
Scorett
Seventh Generation
Sier Disposables
Snickers Workwear
Stadium
Stierna Equestrian Sportswear
Suntribe
Sympatex
Søstrene Grene
Taiga
Texstar
The Cookware Company
Tranemo Advanced Workwear
Trenchant Textiles
Urbanears
Vinga
Vita Verde
Zound Industries

Financial investors are asking for an end to PFAS production

The concern about PFAS is also shared among representatives from the financial community where more than 50 investors with US $11 trillion under management have joined the Investor Initiative on Hazardous Chemicals (IIHC) to engage chemical producers on their production of hazardous chemicals.[52]

The initiative aims to reduce the impacts on human health and the environment from the manufacture of hazardous chemicals, thereby reducing financial risks to investors in these companies from litigation, regulation, and threats to license to operate. The initiative asks chemical producers to increase transparency and end production of persistent chemicals. The initiative is a follow-up from a joint letter that was sent in the end of 2022.[53] The letter refers to the tsunami of recent litigation brought against PFAS manufacturers, the ever-increasing regulation, and the compounds' public health threat.[54]

The investors engaged in the Investor Initiative of Hazardous Chemicals (IIHC) are:

Achmea
Adrian Dominican Sisters
Aequo Shareholder Engagement Services
AkademikerPension
Allianz Investment Management SE
Amundi Asset Management
AP1 (Första AP-fonden)
AP2 (Andra AP-fonden)
AP3 (Tredje AP-fonden)
AP4 (Fjärde AP-fonden)
AP7 (Sjunde AP-fonden)
Aviva Investors
Axa Investment Managers
Bailard
BNP Paribas Asset Management
Boston Common Asset Management
Cardano AM
Columbia Threadneedle Investments
Comgest Group
Committee on Mission Responsibility Through Investment of the Presbyterian Church U.S.A.
CommonSpirit Health
Congregation of St. Joseph
Credit Suisse Asset Management
DNB Asset Management
Domini Impact Investments
EOS at Federated Hermes
Ethos Foundation
First Affirmative Financial Network
Folksam
Handelsbanken Fonder
Harrington Investments, Inc.

Impax Asset Management LCC
KLP Asset Management
La Française Group
LOIM
Mercy Investment Services, Inc.
Nordea Asset Management
Öhman Fonder
Rathbones Group Plc
Resona Asset Management Co., Ltd.
Robeco
SCOR SE
Sisters of St. Francis of Philadelphia
Skandia
Storebrand Asset Management
Swedbank Robur
Trillium Asset Management
Trinity Health
Triodos Investment Management
Vancity Investment Management
WHEB Asset Management
Zurich Insurance Group Ltd

Conclusions

The urgency to resolve the PFAS situation is increasing every day. The multitude of reports, articles, studies, and books, describing the dire situation is a clear indication that we need to reduce the amount of PFAS being produced – and we need to do it fast!

Many relevant stakeholders are convinced that the issue needs a new way forward, including politicians, brands, retailers, chemical producers, investors, - the entire value chain - agree that we need to act.

The proposed PFAS restriction is the best way to, in an efficient and legislative predictable way, phase out the use of PFAS. This way forward is also in line with the Chemicals Strategy for Sustainability as well as an important step to reducing the overall exposure to hazardous chemicals. Continuous use and production of persistent chemicals needs to end, and legislation covering all PFAS in all uses is the most effective way to ensure this.

To reduce the potential for regrettable substitution we need the restriction to be *comprehensive* and *include all relevant persistent PFAS*, and we need the derogations to be as narrow and time limited as possible and *only* for uses that are critical for society and where there are no viable alternatives today.

ChemSec - supporting tools for substitution and important information sources

ChemSec remains dedicated to support both regulators and companies in the transition to a future without PFAS. As part of this work, we have developed several tools and information sources that all companies are free to make use of. For example, ChemSec provides a range

of tools which supports the whole substitution process with focus on ensuring that the alternatives are indeed safer, avoiding regrettable substitution. See below for a short overview of the available tools.

- **The SIN List**[55]**:** PFAS have been included in the SIN list, based on registration data from EU and US. In this update, 416 CAS numbers were added to simplify communication with, for example, the supply chain[56]
- **PFAS guide**[57]: A tool to identify PFAS functions and uses for different sectors and products, aimed at supporting companies in understanding the impact of PFAS on their business. In addition, the PFAS Guide provides information on the PFAS issue, regulation of PFAS, substitution and safer alternatives, as well as links to other important sources of information related to PFAS.
- **ChemSec Marketplace**[58]**:** We have established a **dedicated PFAS section in marketplace** where companies can find safer alternatives to PFAS. At the platform they can establish direct contact to the alternative providers.[59]

Further relevant information:

- Check your tech – guide to PFAS electronics[60]
- Lost at SEA[61]
- The bigger picture[62]
- ChemSec webinars[63]

References

1. Gaber et al, (2023). The Devil they Knew: Chemical Documents Analysis of Industry Influence on PFAS Science. *Annals of Global Health, 89, 1.*
2. Environmental Working group, 2019, For decades, polluters knew PFAS chemicals were dangerous but hid risks from public: https://www.ewg.org/research/decades-polluters-knew-pfas-chemicals-were-dangerous-hid-risks-public
3. The Forever Pollution Project - Journalists tracking PFAS across Europe, 2023: https://foreverpollution.eu/
4. Bach et al, (2016). Perfluoroalkyl Acids in Maternal Serum and Indices of Fetal Growth: The Aarhus Birth Cohort. Environmental Health Perspectives, 124, 6.
5. Calafat et al (2007). Polyfluoroalkyl Chemicals in the U.S. Population: Data from the National Health and Nutrition Examination Survey (NHANES) 2003–2004 and Comparisons with NHANES 1999–2000. *Environmental Health Perspectives*, 115, 11.
6. Richterová et al (2023). PFAS levels and determinants of variability in exposure in European teenagers – Results from the HBM4EU aligned studies (2014–2021). *International Journal of Hygiene and Environmental Health*, 247, 114057.
7. Cousins, I. T., Johansson, J. H., Salter, M. E., Sha, B., & Scheringer, M. (2022). Outside the safe operating space of a new planetary boundary for per-and polyfluoroalkyl substances (PFAS). *Environmental Science & Technology*, *56*(16), 11172-11179.
8. ChemSec, 2023: ChemSec identifies the top 12 PFAS producers in the world and reveals shocking societal costs: https://chemsec.org/chemsec-identifies-the-top-12-pfas-producers-in-the-world-and-reveals-shocking-societal-costs/
9. The Nordic Council, 2019: The cost of inaction: A socioeconomic analysis of environmental and health impacts linked to exposure to PFAS: http://norden.divaportal.org/smash/record.jsf?pid=diva2%3A1295959&dswid=-9587
10. Minderoo, 2022: The social cost of plastic pollution: https://cdn.minderoo.org/content/uploads/2022/10/13131230/The-Price-of-Plastic-Pollution-Annex-1.pdf
11. Smalling et al (2023). Per- and polyfluoroalkyl substances (PFAS) in United States tapwater: Comparison of underserved private-well and public-supply exposures and associated health implications. *Environment International* 178, 108033.
12. Eureau, 2020: PFAS and drinking water: https://www.eureau.org/resources/briefing-notes/5236-briefing-note-on-pfas-and-drinking-water/file
13. Naturskyddsföreningen, 2023: För höga halter PFAS i svenska kräftor: https://www.sverigesnatur.org/aktuellt/for-hoga-halter-pfas-i-svenska-kraftor/
14. EFSA Scientific opinion, 2020: Risk to human health related to the presence of perfluoroalkyl substances in food: https://efsa.onlinelibrary.wiley.com/doi/full/10.2903/j.efsa.2020.6223
15. NL Times 2023: Netherlands will hold 3M liable for PFAS "forever chemicals" in Westerschelde: https://nltimes.nl/2023/05/23/netherlands-will-hold-3m-liable-pfas-forever-chemicals-westerschelde
16. DTU 2023: PFAS found in organic eggs in Denmark: https://www.food.dtu.dk/english/newsarchive/2023/01/pfas-found-in-organic-eggs-in-denmark
17. Cousins et al (2019). Why is high persistence alone a major cause of concern? *Environ. Sci.: Processes Impacts*, 2019,21, 781-792
18. Martin Scheringer, Jana H. Johansson, Matthew E. Salter, Bo Sha, and Ian T. Cousins, 2022, Stories of Global Chemical Pollution: Will We Ever Understand Environmental Persistence?

    Environmental Science & Technology **2022** *56* (24), 17498-17501 DOI: 10.1021/acs.est.2c06611
19. COMMISSION REGULATION (EU) …/… of XXX amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards synthetic polymer microparticles https://ec.europa.eu/transparency/comitology-register/screen/documents/083921/1/consult?lang=en

20. ECHA 2023: Restriction on the manufacture, placing on the market and use of PFASs.https://echa.europa.eu/sv/registry-of-restriction-intentions/-/dislist/details/0b0236e18663449b
21. Ahearn, A. (2019). A Regrettable Substitute: The Story of GenX. *The Researcher's Perspective*, 1, 2019.
22. Atmo, 2022: The Rising Threat of HFOs and TFA to Health and the Environment: https://atmosphere.cool/hfo-tfa-report/
23. Wang Z, Buser AM, Cousins IT, Demattio S, Drost W, Johansson O, Ohno K, Patlewicz G, Richard AM, Walker GW, White GS, Leinala E. A New OECD Definition for Per- and Polyfluoroalkyl Substances. Environ Sci Technol. 2021 Dec 7;55(23):15575-15578. doi: 10.1021/acs.est.1c06896. Epub 2021 Nov 9. PMID: 34751569.
24. Rainer Lohmann, Ian T. Cousins, Jamie C. DeWitt, Juliane Glüge, Gretta Goldenman, Dorte Herzke, Andrew B. Lindstrom, Mark F. Miller, Carla A. Ng, Sharyle Patton, Martin Scheringer, Xenia Trier, and Zhanyun Wan, 2020, Are Fluoropolymers Really of Low Concern for Human and Environmental Health and Separate from Other PFAS? *Environmental Science & Technology* **2020** *54* (20), 12820-12828DOI: 10.1021/acs.est.0c03244
25. UBA, 2021: Persistent degradation products of halogenated refrigerants and blowing agents in the environment: type, environmental concentrations, and fate with particular regard to new halogenated substitutes with low global warming potential: https://www.umweltbundesamt.de/en/publikationen/persistent-degradation-products-of-halogenated
26. Lohmann, R., & Letcher, R. J. (2023). The universe of fluorinated polymers and polymeric substances and potential environmental impacts and concerns. *Current Opinion in Green and Sustainable Chemistry 41*, 100795.
27. Lohmann, R., Cousins, I. T., DeWitt, J. C., Gluge, J., Goldenman, G., Herzke, D., ... & Wang, Z. (2020). Are fluoropolymers really of low concern for human and environmental health and separate from other PFAS?. *Environmental science & technology*, *54*(20), 12820-12828
28. Bergmann et al (2017). High quantities of microplastic in Arctic deep-sea sediments from the HAUSGARTEN observatory. *Environmental science & technology*, *51*(19), 11000-11010.
29. Capillo et al (2020). Quali-quantitative analysis of plastics and synthetic microfibers found in demersal species from Southern Tyrrhenian Sea (Central Mediterranean). *Marine pollution bulletin*, *150*, 110596
30. Xavier Dauchy, 2023: Evidence of large-scale deposition of airborne emissions of per- and polyfluoroalkyl substances (PFASs) near a fluoropolymer production plant in an urban area, Chemosphere, Volume 337, October 2023, 139407: https://www.sciencedirect.com/science/article/pii/S0045653523016740
31. OECD def for Polymers of low concern https://www.oecd.org/env/ehs/risk-assessment/42081261.pdf
32. ChemSec 2023: Slam debunkin' three myths about fluoropolymers: https://chemsec.org/slam-debunkin-three-myths-about-fluoropolymers/
33. Wood Group UK 2022: Update of market data for the socio- economic analysis (SEA) of the European fluoropolymer industry https://fluoropolymers.plasticseurope.org/application/files/1216/5485/3500/Fluoropolymers_Market_Data_Update_-_Final_report_-_May_2022.pdf
34. HEAL 2023: How PFAS pollution affects people's health across Europehttps://www.env-health.org/BanPFAS/
35. Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006 Text with EEA relevance
36. ATMOsphere's Marketplaces: https://atmosphere.cool/marketplaces/
37. Joudan et al (2021). Insufficient evidence for the existence of natural trifluoroacetic acid. *Environmental Science: Processes & Impacts*, *23*(11), 1641-1649.
38. Pickard et al (2020). Ice core record of persistent short-chain fluorinated alkyl acids: Evidence of the impact from global environmental regulations. *Geophysical Research Letters*, *47*(10), e2020GL087535.
39. ChemSec Marketplace: https://marketplace.chemsec.org/
40. CIEL, 2013: Driving Innovation, How stronger laws help bring safer chemicals to the market :https://www.ciel.org/Publications/Innovation_Chemical_Feb2013.pdf
41. ChemSec webinar, 2023: Find out how to replace "difficult" PFAS uses with safer alternatives: https://chemsec.org/find-out-how-to-replace-difficult-pfas-uses-with-safer-alternatives/

42. Sharma et al (2023). Safer and effective alternatives to perfluoroalkyl-based surfactants in etching solutions for the semiconductor industry. *Journal of Cleaner Production, 415, 2023.*
43. Erhvervsøkonomiske konsekvenser ved en national grænseværdi for indhold af totalt organisk bundet fluor i fødevarekontaktmaterialer. https://www.ft.dk/samling/20142/almdel/MOF/spm/84/svar/1263934/1547471.pdf
44. https://ionomr.com/
45. https://www.ionysis.com/
46. https://www.cellfion.se/
47. https://actnano.com/
48. https://www.nanoramic.com/
49. See excel sheet "ChemSec-PFAS-Consultation-reply_AlternativesExcel.xlsx" attached to this reply
50. https://chemsec.org/pfas
51. ChemSec 2023: How companies view PFAS and the EU's restriction proposal: https://chemsec.org/reports/how-companies-view-pfas-and-the-eus-great-restriction-proposal/)
52. Investor Initiative on Hazardous Chemicals https://chemsec.org/knowledge/IIHC/
53. ChemSec, 2022: Investors with $8 trillion call for phase-out of dangerous "forever chemicals"https://chemsec.org/investors-with-8-trillion-call-for-phase-out-of-dangerous-forever-chemicals/
54. The Guardian, 2023: Investors pressure top firms to halt production of toxic 'forever chemicals'https://www.theguardian.com/environment/2023/jan/06/pfas-toxic-forever-chemicals-manufacturers
55. ChemSec SIN List: https://sinlist.chemsec.org
56. PFAS on the ChemSec SIN List: https://sinlist.chemsec.org/pfas/
57. The PFAS Guide: https://pfas.chemsec.org
58. ChemSec Marketplace: https://marketplace.chemsec.org
59. PFAS alternatives on ChemSec Marketplace: https://marketplace.chemsec.org/alternatives?groups=10
60. ChemSec, 2023: Check Your Tech! A Guide to PFAS in Electronics: https://chemsec.org/reports/check-your-tech-a-guide-to-pfas-in-electronics/
61. ChemSec, 2019: Lost at SEA*The information policymakers actually need from applicants and SEAC opinionshttps://chemsec.org/reports/lost-at-sea/
62. ChemSec, 2016: The Bigger Picture – Assessing economic aspects of chemicals substitution: https://chemsec.org/reports/the-bigger-picture-assessing-economic-aspects-of-chemicals-substitution-2016/
63. Recorded ChemSec Webinars: https://www.youtube.com/playlist?list=PLjw_E2ESVtnl9Hj6dIk1MyB2xfp8gDpa5