ANALYSIS OF ALTERNATIVES

and

SOCIO-ECONOMIC ANALYSIS

PROVIDED AS COMMENTS TO THE PUBLIC CONSULTATION ON THE REACH RESTRICTION PROPOSAL ON PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)

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Date:	22.09.2023

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LIST OF ABBREVIATIONS

4MS	The Four Member States (Germany, France, the Netherlands and the United Kingdom of Great Britain and Northern Ireland)
ACS	Attestation de Conformité Sanitaire
AISBL	Aqua Europa
AoA	Analysis of Alternatives
AOX	Adsorbable Organic Halides
BAT	Best Available Techniques
CMR	Carcinogenic, Mutagenic, Reprotoxic
DG ENV	Directorate-General for Environment
DGMT	German society for membrane technology
DVGW	Deutscher Verein des Gas- und Wasserfaches e.V.
DWD	Drinking Water Directive
EBIT	Earnings Before Interest and Tax
ECHA	European Chemicals Agency
ECTFE	Ethylenechlorotrifluoroethylene
EDW	European Drinking Water Alliance
EEA	European Economic Area
EiF	Entry into Force
EN	European Standard
EPDM	Ethylene-propylene-diene(monomer) rubber
ETFE	Ethylene-tetrafluoroethylene copolymer
EU	European Union
FEP	Fluorinated ethylene propylene
FFKM	Perfluoroelastomers
figawa	German association of companies for gas and water technologies
FKM	Fluoro rubbers
FKM-NBR	Fluoro rubbers
FP	Fluoropolymers
FPM	Fluoro rubbers
HAI	Hospital-acquired Infections
HNBR	Nitrile butadiene rubber
IED	Industrial Emissions Directive

ISO	International Organization for Standardization
KTW-BWGL	Bewertungsgrundlage für Kunststoffe und andere organische Materialien im Kontakt mit Trinkwasser
LCI	Labour Cost Index
MEErP	Methodology for Ecodesign of Energy-related Products
MoS2	Molybdenum disulfide
NBR	Nitrile butadiene rubber
NSF	The National Sanitation Foundation
NPV	Net Present Value
OEM	Original Equipment Manufacturer
PA	Polyamide
Pb	Lead
PE	Polyethylene
PFA	Perfluoralkoxy alkane
PFAS	Per-and polyfluoroalkyl substances
PFPE	Perfluoropolyethers
PLC	Polymer of Low Concern
PP	Polypropylene
PPSU	Polyphenylsulfone
PSU	Polysulfone
PTFE	Polytetrafluoroethylene
PU	Polyurethane
PVC-C	Polyvinylchloride
PVC-U	Polyvinylchloride
PVDF	Polyvinylidene fluoride
R&D	Research and Development
RO	Restriction Option
SCFP	Side-chain fluorinated polymers
SME	Small and Medium-sized Enterprises
SVHC	Substance of very high concern
Teppfa	The European Plastic Pipes and Fittings Association
UBA	Umweltbundesamt
US	United States

UWWTD	Urban Wastewater Treatment Directive
WRAS	Water Regulations Advisory Scheme
WRR	Water Reuse Regulation

SUMMARY

The present document is part of the submission of figawa e.V., DGMT and AE for the public consultation on the PFAS restriction proposal.

It describes the use of fluoropolymers (FPs) in products used for water supply systems, which include the provision of industrial process water and municipal drinking water using a system of pipes, pumps, meters, faucets, showers and shower systems, and other equipment. The applications range from small-scale, private household uses up to large scale, municipal or governmental water supply infrastructure.

Public as well as private and industrial water supply systems are generally designed for a long service life (at least several decades) and there is limited access for maintenance and repair (e.g. in underground public water supply systems and wall installations). Therefore, especially components that must meet mechanical requirements such as sliding or sealing must function for a long time without being serviced. FPs are commonly used materials for these components. Their inherent stability prevents the migration of any harmful substances from the components into (drinking-) water. Their excellent material properties, such as temperature- and pressure resistance, tensile strength and impact resistance, results in very high leak tightness that prevents leakage of water.

FPs are high-performance materials with exceptional properties, such as chemical resistance, thermal stability, fouling resistance, material flexibility and anti-friction / gliding properties. There is no other available material that combines this wide range of functions and therefore no suitable alternatives exist at this time. Hence, figawa primarily supports an exemption of FPs by way of a time-unlimited derogation for the water supply applications or at least the longest derogation period to perform the research necessary to find and implement alternatives that meet high standards, which would certainly require more than 20 years.

In summary, the consequences of a PFAS restriction, as outlined by the socioeconomic evaluation including social costs of unemployment, producer surplus losses and additional one-off investment costs amount to roughly 1,848.03 million Euros (NPV 2025) or 75.37 million Euros annually over a 45-year period. While the assessment accounts only for input from figawa members within the scope of this assessment, it is crucial to underscore the extensive ramifications such a restriction, without the requested exemption, would have on the EEA society as a whole.

1. Introduction

This comment is submitted in the name of figawa e.V.[1], the German association of companies for gas and water technologies supported by DGMT e.V.[2] (German society for membrane technology) and Aqua Europa AE[3]. Our members provide products and services for the utilisation and distribution of gas and liquid fuels as well as the distribution and the treatment of drinking water and water for industrial and municipal purposes including wastewater and pool water treatment.

figawa has more than 275 member companies, which generate around 34 billion Euros of revenues annually. As an industry association, we bring together interests and advocate for standardized regulations and legislative processes to ensure long-term legal and planning certainty for all market participants. With our expertise, technology, and open dialogue, we aim to drive progress and innovation in our industries in the EU. Cross-cutting issues, as well as needs and requirements of our members are addressed in our industry aligned sector coordination groups.

The figawa members have aligned into three clusters based on the presence of PFAS in their product portfolio and applications to provide comments for the PFAS restriction proposal. These clusters are:

1. Water treatment (drinking water, wastewater, industrial water, water reuse and pool water)

2. Water supply (public infrastructure, water distribution in buildings and water measurement and distribution of thermal energy) and

3. Gas & liquid fuels (application and distribution)

To fulfil their responsibility of providing millions of private households, municipalities (including their infrastructure of critical and systemic importance, such as clinics and hospitals), and industry with resources such as gas, liquid fuels, and water, our members depend on a variety of fluoropolymer-based technical components, all of which with high requirements towards their mechanical and chemical properties. This does not only guarantee a functioning infrastructure with an enormous economic impact on the European society but also the very safety of the European population.

It is important to note that figawa members are not manufacturers of per- and polyfluoroalkyl substances (PFAS) or polymer PFAS raw material. They mainly assemble end-products from components and are only a part of the supply-chain. They are thus not directly involved in the development process of PFAS-free alternatives, which exhibit the complex set of physicochemical properties required for their products. It is additionally worth noting that due to the members' position in the supply chain, the exact composition of components in relation to PFAS is often unknown to them.

[1] https://figawa.org/
[2] https://www.dgmt.org/the-dgmt.html
[3] https://aqua-europa.eu/

Under this premise, the members identified that polymeric PFAS are of extraordinary importance for the safe and durable operation of their products. Polymeric PFAS may be categorized into three groups: Fluoropolymers (FPs), perfluoropolyethers (PFPEs), and side-chain fluorinated polymers (SCFPs) (ECHA, 2023) (Korzeniowski, et al., 2023). Of these three classes, FPs including fluoroplastics (e.g. polytetrafluoroethylene (PTFE) or polyvinylidene fluoride (PVDF)) and fluoroelastomers (e.g. fluorine rubber (FKM)) are the most important for the figawa members. This is also reflected by the first comment submitted by figawa[4], in which a time-unlimited derogation for FPs was proposed. The importance of FPs for the members' products becomes apparent when analysing the components used for the manufacture of their end-products (see section 2.1).

FPs have very high molecular weight (Korzeniowski, et al., 2023) and show excellent thermal, chemical, photochemical, oxidative, hydrolytic and biological stability with low flammability, neutral electrical charge and resistance to degradation. No reactive groups are present in the structure of FPs. They are characterized by a carbon-only polymer backbone with F atoms directly attached to it, a unique feature in the chemical space. FPs do not bioaccumulate, are not mobile and fulfil the Polymer of Low Concern (PLC) criteria (OECD, 2009).

The following report addresses the products and the respective applications for '**Cluster 2: Water supply**'. It is the consolidated information of figawa's members and aims to represent the European water supply sector. The report provides an overview on where FPs are present and what functionalities are provided by them. In addition, potential alternatives are discussed in section 2 and a hypothetical substitution timeline is presented in section 3. Socio-economic impacts of a potential restriction of PFAS are described in section 4.

1.1. Water Supply

Water supply describes the provision of industrial process water and municipal drinking water using a system of pipes, pumps, meters, faucets, showers and shower systems, and other equipment. The applications range from small-scale, private household uses up to large scale, municipal or governmental water supply infrastructure.

The process of water supply takes place once water has been treated (see documents for Cluster 1 for more details) and is ready for supply. It therefore involves:

- Any under- or aboveground pipeline systems
- Storage facilities
- Pumping stations
- Pipe network for distribution
- Industrial & commercial water supply systems

[4] Comment 4433 from 2023-06-02 accessible via https://echa.europa.eu/documents/10162/8d917581-7faf-4e1a-26d4-073d52b3406e (last accessed 2023-09-15)

- Private household water supply systems.

1.2. EU Regulations / Directives

Of all global water resources, only 0.5 % are useable and available freshwater sources and water scarcity is one of the main challenges of the century. Currently, more than 3 billion people face water scarcity every year and this number will increase to 5 billion by 2050 (UN Water, n.d.). Protecting water resources and re-use of any (waste-)water is thus of crucial importance for society.

It is therefore no surprise that several policy initiatives are addressing this issue and aim to protect water resources. In the EU, the Commission has launched the 'Blueprint to Safeguard Europe's Water Resources' in 2012, an approach which aims to improve current EU water legislations (Kurrer & Lipcaneanu, 2023). In the following, a selection of relevant EU legislations is presented that govern the treatment and management of water and wastewater.

Drinking Water Directive (EU) 2020/2184 (DWD) (EUR-Lex, 2020a) The DWD aims to ensure the quality of water intended for human consumption. It provides maximum allowed levels for various contaminants, such as heavy metals. This is done by providing definitions for water quality standards and descriptions on control and monitoring. The DWD further ensures access, protects sources and distribution of drinking water. It also provides legal basis for the harmonisation of materials and products in contact with drinking water, such as FPs, which according to the DWD are suitable to be used for drinking water.

The revised DWD came into force in January 2021 with an updated list of substances subject to monitoring and (lower) limit values, among others (e.g. in in Annex III). The DWD mentions 'Sum of PFAS' subject to monitoring, and lists specific PFAS substances. It must be highlighted that no FPs (e.g. PTFE) are mentioned here. This means that according to the DWD FPs are suitable for drinking water, as they do not pose any "adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean" (Article 1 of DWD).

Urban Wastewater Treatment Directive 91/271/EEC (UWWTD) (EUR-Lex, 2014)

The UWWTD requires the collection and treatment of urban wastewater to protect human health. It sets discharge limit values to ensure that releases of nutrients and pollutants are safe.

Industrial Emissions Directive 2010/75/EU (IED) (EUR-Lex, 2011)

The IED regulates pollution from industrial activities. Best Available Techniques (BAT) must be followed to ensure that emissions of chemicals to the environment are prevented or minimised.

Regulation (EU) 2020/741 on minimum requirement for water reuse (Water Reuse Regulation / WRR) (EUR-Lex, 2020b)

The WRR provides minimum water quality requirements for the safe reuse of treated urban wastewaters in agricultural irrigation.

The legislations shown above illustrate that the implementation of BATs is not optional but an absolute requirement to ensure that both the society and the environment are provided with clean and safe (drinking) water.

Ecodesign Directive 2009/125/EC (EUR-Lex, 2012)

The Ecodesign Directive sets requirements for specific product groups to significantly improve their circularity, energy performance and other environmental sustainability aspects. Water supply products (sanitary equipment) belong to one of the assessed product groups, as they have the potential for energy reduction.

FPs in use do not only significantly increase product durability, thereby saving energy throughout their lifecycle, but reduce wear and tear, as well as improve gliding properties of components, which saves energy. Hence without the use of FPs, the objectives of the Ecodesign Directive will be jeopardised.

2. ANALYSIS OF ALTERNATIVES

2.1. Fluoropolymers and Fluoropolymer-containing components

All submitted comments and documents describe the use of FPs for each cluster, respectively. Short-chain PFAS are not in scope of this submission.

Public as well as private and industrial water supply systems are generally designed for a long service life (at least several decades) and there is limited access for maintenance and repair (e.g. in underground public water supply systems and wall installations). Therefore, especially components that must meet mechanical requirements such as sliding or sealing must function for a long time without being serviced. Furthermore, their inherent stability prevents the migration of any harmful substances from the components into (drinking-) water. The excellent material properties of FPs, such as temperature- and pressure resistance, tensile strength and impact resistance, results in very high leak tightness that prevents leakage of water. Examples are shaft seals and O-rings used in such as valves and fittings, pumps, pipelines and faucets that prevent water from leaking.

The commonly used materials for these components are FPs such as e.g. FKM, PTFE and PFA. In the long term, the use of substitute products might only be possible in certain areas but would require major design changes. Supply of spare and maintenance parts for existing networks in operation may not be possible and may result in expensive replacements before the end of service life. The vast number of affected networks with such technology would require immense investments. Altogether this could endanger public and industrial water supply and the benefit for the environment is marginal as materials in contact with drinking water are already subject to high standards.

Table 1 provides an overview on which FPs are commonly used in water supply applications.

TABLE 1: OVERVIEW ON RELEVANT FPS AND THEIR FIELD OF APPLICATION IN WATER SUPPLY

Fluoropolymer used in water supply (non-exhaustive)	**Fluoropolymer abbreviation**	**Associated components in which the fluoropolymer is used (non-exhaustive exemplification)**
Ethylenechlorotrifluoroethylene	ECTFE	Pipes, fittings, valves
Ethylene-tetrafluoroethylene copolymer	ETFE	Connection pipes
Fluorinated ethylene propylene	FEP	Connection pipes
Perfluoroelastomers	FFKM	Membranes

Fluoro rubbers	FPM, FKM FKM-NBR	Sealing rings, membranes, transducers
Perfluoropolyether	PFPE	Transducers
Polytetrafluoroethylene	PTFE PTFE-coated EPDM	Lubricant, sealing rings, sealing materials, cables, membranes, ball valves
Polyvinylidene fluoride	PVDF	Pipes, fittings, valves, axial compression sleeves

Water supply products encompass a wide range of product groups, which consist of several individual components. The participants of this cluster reported to mainly produce pipes/piping systems (end-product group 4) and faucets/showers (end-product group 1). An illustrative distribution of end-product groups is depicted in Figure 1. A detailed description is provided in the Chemical Safety Report of this submission.

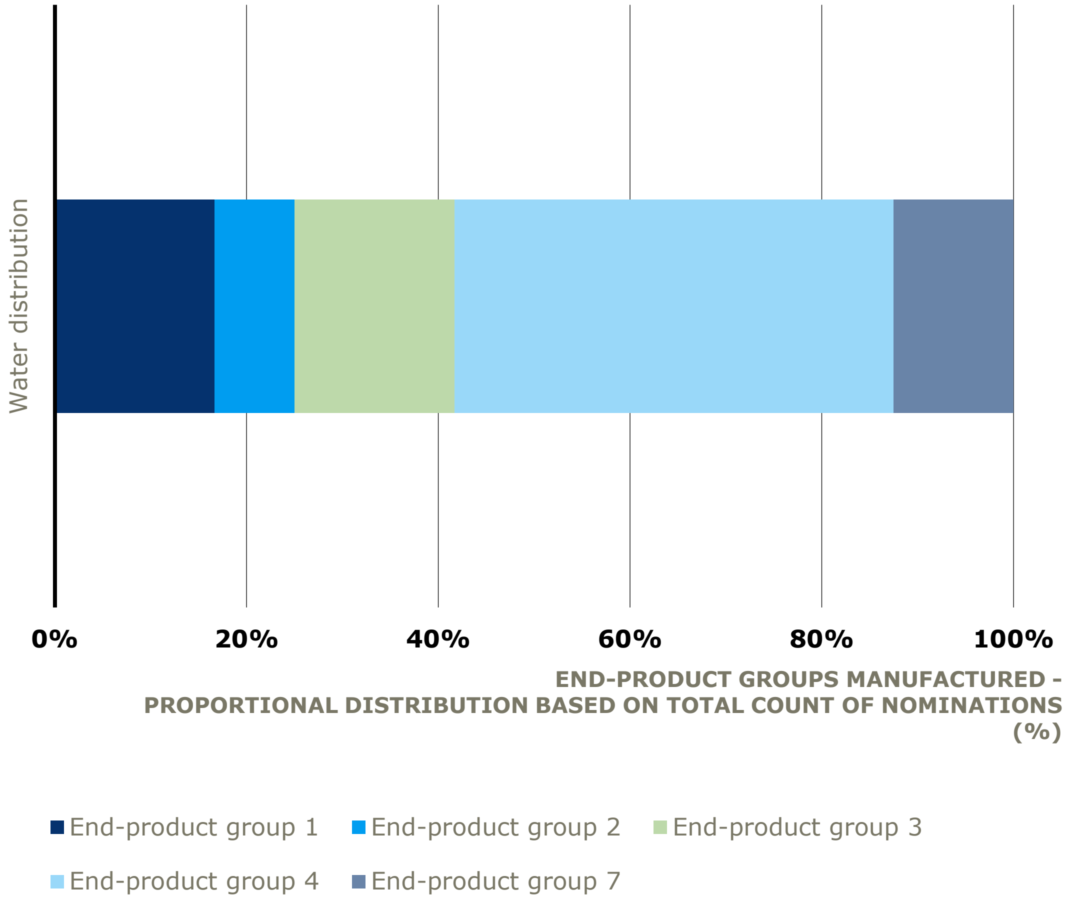

FIGURE 1: END-PRODUCT GROUPS MANUFACTURED WITHIN CLUSTER.

Groups are defined as End-product group 1: Faucets, showers; End-product group 2: Seals, (O-)rings, membranes, sleeves; End-product group 3: Ball valves, valves, butterfly valves, flow/pressure regulators and monitors, injectors; End-product group 4: Pipes, piping systems (for showers, sinks, drinking water, drainage); End-product group 7: Meters, sensors, analysis tools and controls. Please refer to the Chemical Safety Report for further details.

Table 2provides an overview on the component groups and the related end-product groups for which they are used. In consistency to the structure of the market – end-products are mostly assembled from various components – several FP-containing components are used per end-product group. Also, the same components may be used in different end-product groups. For example, (O-)rings and other sealings as well as lubricants are used in most end-product groups.

TABLE 2: FP-CONTAINING COMPONENTS AND USE IN END-PRODUCT GROUPS

Component group	Component details	End-product group				
		1	2	3	4	7
1	Spacers, anchors, caps, nozzles, fittings, ball valves, pump heads, hose connections/hoses, valves/valve seats	+	-	-	+	+
2	Use as processing aid, contact passivation, etc.	-	-	-	+	-
3	Electronic components (circuit boards, displays, injection units, flow meters / sensors, etc.), cables, batteries	-	-	-	+	+
4	Housings, containers, reactors, flame retardant plastic components	-	-	-	-	+
6	Membranes	-	+	-	-	+
7	O-rings, retaining rings, shaft seals, molded seals (gaskets)/(flat) sealings	+	+	+	+	+
8	Lubricants (greases, oils), lubricant coatings, bearings	+	-	+	+	+

Acronyms: **+**: Components used for the manufacture of this end-product group; **-**: Components not used for the manufacture of this end-product group; **End-product group 1**: Faucets, showers; **End-product group 2**:

Seals, (O-)rings, membranes, sleeves; **End-product group 3**: Ball valves, valves, butterfly valves, flow/pressure regulators and monitors, injectors; **End-product group 4**: Pipes, piping systems (for showers, sinks, drinking water, drainage); **End-product group 7**: Meters, sensors, analysis tools and controls

It must be highlighted that the main group of products, which are the focus of the submission, are products/components in direct contact with water (drinking water, process water etc.). These products/components must show high chemical inertness, temperature- and pressure resistance and provide further functions, such as material flexibility and gliding properties in order to withstand the broad range of application parameters.

However, this submission also includes products needed in water supply, such as control technology components (e.g. meters, sensors), which include FP-containing parts. While direct contact to water is usually not the case, these products are needed for the safe operation of water supply processes. Hence, they are mentioned here for information purposes.

The following figures illustrate components containing FPs as used in water supply systems as a non-exhaustive exemplification for the scope of the current report (Figure 2 to Figure 4).

FIGURE 2: SLIDE GATE VALVE WITH PTFE LINING.

FIGURE 3: TAPPING SADDLE WITH PTFE COATING

FIGURE 4: KITCHEN FAUCET

Faucets contain FPs, among other lubricants that ensure gliding properties of movable parts, thus enabling significantly longer product lifetimes.

2.1.1. The value chain of FPs in water distribution systems

Public infrastructure, water distribution systems in buildings, and water measurement systems are designed to have a long service life, typically spanning several decades. In many cases, these systems have limited accessibility for maintenance and repair, making it crucial for components with mechanical requirements, such as gliding or sealing elements, to function reliably over extended periods without the need for frequent servicing. Additionally, these components' inherent stability is essential to prevent the migration of harmful substances into the drinking water.

Examples of critical components in these systems include shaft seals, O-rings, valves, fittings, pumps, pipelines, and faucets which play a vital role in preventing water leakage and ensuring the integrity of the water supply. To meet the demanding requirements, FPs like FKM, PTFE, and PFA are commonly used due to their excellent mechanical properties and stability. These FPs ensure the long-term effectiveness and safety of water distribution systems. The material properties and low friction coefficient of FPs make them the most suitable materials for sealing and gliding applications. FP-based lubricants for example are used in faucets and in other components with movable components. The lubricants enhance and ensure the gliding properties during the required long service life and significantly reduce wear-tear of components.

The extensive use of FPs is of critical due to concerns about the availability of spare parts and maintenance for existing water distribution networks. Premature component replacements could result in significant costs for both public and industrial water supply systems. Thus, the reliability and longevity of FPs play a crucial role in ensuring the continuous and safe functioning of these vital water supply networks. Overall, the reliance on FPs in water distribution components is critical to ensure the continuous and safe functioning of water supply networks. The use of these materials is already subject to high standards to maintain water quality and safety.

2.1.1.1. Key stakeholders within the value chain

A general overview of the value chain of water distribution systems using components consisting of FPs is depicted in Figure 5. The value chain comprises of **manufacturers producing FPs and downstream companies processing the respective substances** (e.g., into pellets and powders) for a variety of use applications. The processed FPs are further provided to **component manufacturers** which produce parts/components dependent on the substances as part of their portfolio. The respective fluoropolymer-based components are then sold to **original equipment manufacturers (OEMs) of water distribution systems** for numerous applications. These uses include for instance, the sanitary market, plumbers/installers and public utilities/heating installations.

The main customers and stakeholders of water treatment technologies using fluoropolymer-based components can be broadly categorized into the **sanitary industry, plumbers/installers, OEMs, public and private utilities and infrastructure**. Figure 5 presents a (very simplified) summary of the main stakeholders in the value chain of water distribution systems using components consisting of FPs.

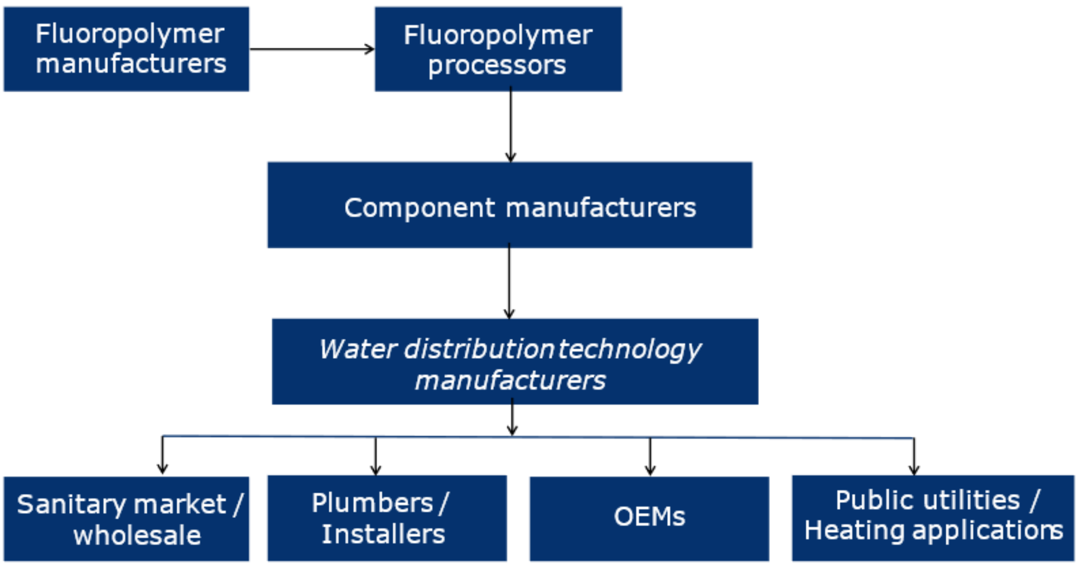

FIGURE 5: SCHEMATIC PROVIDING A SUMMARY OVERVIEW OF THE MAIN STAKEHOLDERS IN THE VALUE CHAIN OF WATER DISTRIBUTION TECHNOLOGIES AND SYSTEMS USING FLUOROPOLYMER-BASED COMPONENTS.

A non-exhaustive overview of the main customers of water distribution systems using fluoropolymer-based components is listed below:

- Sanitary market
- Specialist wholesalers of sanitary products, for plumbing
- Plumbers/installers: 50,000 installers in Europe (mostly SMEs) use piping systems of one producer for water installations inside buildings.
- Water distribution
- Metering services
- Public and private utilities

Other downstream users in the supply chain comprise (apart from those already mentioned as customers):

- Wholesalers who also market via online platforms and/or installers
- Original equipment manufacturers (OEMs)
- Industrial customers in various segments
- Subsidiaries in other EEA countries
- Clinics and hospitals

The distributions and sales channels used are:

- Wholesale (especially plumbing, sanitary and specialist wholesalers)
- Retail trade (especially plumbers)
- Do-it-yourself stores
- E-commerce, internet
- Direct approach to the customer (e.g. OEM)
- Agents

In addition, end consumers should be mentioned here, too, as they are directly dependent on a safe, efficient and functioning water supply infrastructure.

Number of stakeholders involved in the sector across the EEA

A study performed on behalf of Directorate-General for Environment (DG ENV) as support to the implementation and further development of the Drinking Water Directive (98/83/EC), in particular on materials in contact with drinking water focused on 12 of about 150 product categories identified as likely to include products focused on drinking water. The data was indicative of the relevant activities, such as water treatment technologies and water distribution systems. It has been estimated in this study that more than 5,000 companies within the EU are involved in producing finished products used in contact with drinking water. A smaller share of these companies is expected to belong to the sector of water treatment technologies, another and probably larger share to the sector of water distribution systems (Umweltbundesamt GmbH, 2017).

2.1.1.2. Market and financial considerations

The European Plastic Pipes and Fittings Association (Teppfa) estimates the value of plastic pipe production in Europe at around 12 billion Euros, constituting pipes for water, gas, sewerage, and other applications. Although a specific breakdown for each use is unavailable, an upper estimate suggests that between 33 % to 50 % of this value (4 - 6 billion Euros) is attributed to water covering both public distribution pipes and building plumbing systems, with an approximate 50% expenditure on each. For domestic plumbing systems, the most common purchases are likely kitchen and bathroom taps, which receive the most mechanical wear. A 2012 report on the Methodology for Ecodesign of Energy-related Products (MEErP) estimated the annual expenditure for taps to be 4.7 billion Euros, based on Eurostat production and import/export data for the EU. For water distribution systems used in drinking water, the study from the Umweltbundesamt estimates that within the EU, over 100,000 employees work in the production of components specifically designed for these systems. The combined sector generates sales of around 40 billion Euros per year, a figure that aligns with estimates from the Dutch Ministry of Infrastructure and Environment and data provided by the EDW (Umweltbundesamt GmbH, 2017).

The EU's population is supplied with an estimated 27 billion cubic meters of water daily through approximately 5 million km of public distribution system pipes. With around 1.2 billion taps installed in buildings, 406 million showers, and 14 million water pumps, there is a substantial installed base for assembled products related to the pipework (Umweltbundesamt GmbH, 2017).

Proportional to the split in applications for this cluster as explained above, a distribution of the market value between stakeholders (see Section 2.1.1.1) has remained difficult. Given the diversity of stakeholders and components (see Table 1) captured by this sector, only financial estimates of industry stakeholders were estimated with emphasis on figawa members. Overall, it is already evident that there are additional manufacturers of water supply technologies depending on fluoropolymer-based components in the EEA which could not be represented in the current report due to a lack of appropriate data. The data presented was collected in a survey with figawa members and aggregated to give an overview for the companies in the cluster that provided data.

As such, figawa members constitute more than 275 member companies that generated around 34 billion Euros of revenues in 2022. The members covered under the scope of this assessment have reported that, of their individual total revenues, on an average, in 2022 a share of annual revenues of 31 % (ranging between 4 – 100 %) was dedicated to supply of water distribution systems dependent on the components associated with FPs. Similarly, the share of total annual EBITs that are attributed to PFAS was estimated at 84 % on average (ranging between 75 – 100 %) in 2022.

Figure 6 depicts the annual sales revenues registered in the EEA by the figawa members for all products and for products dependent on PFAS respectively. The data shown relates to the financial years 2020, 2021 and 2022.

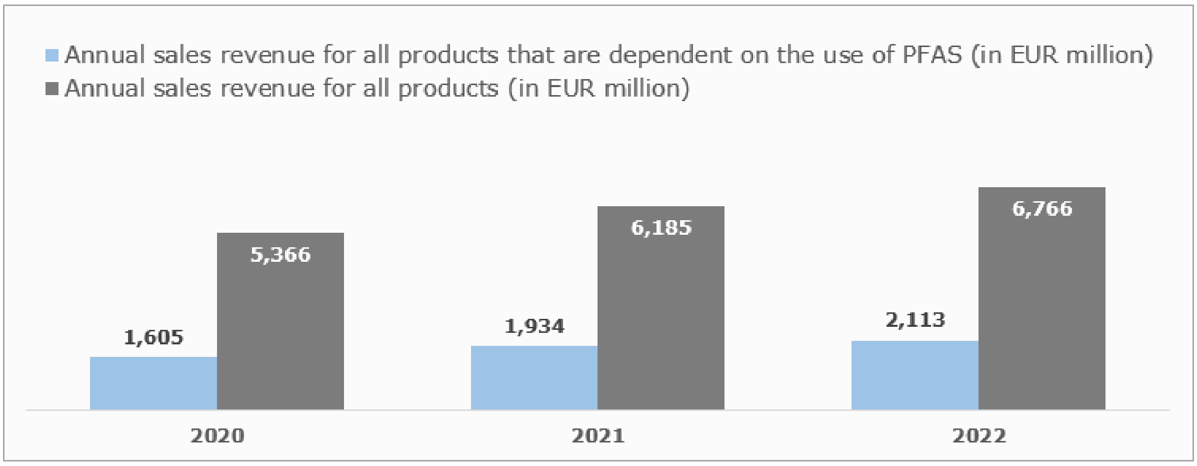

FIGURE 6: TOTAL REVENUES AND PFAS-DEPENDENT REVENUES OF WATER TREATMENT TECHNOLOGIES GENERATED BY FIGAWA MEMBERS.

Figure 7 depicts the annual earnings before interest and tax (EBIT) registered in the EEA by the Figawa members for all products and for products dependent on PFAS respectively. The data shown relates to the financial years 2020, 2021 and 2022.

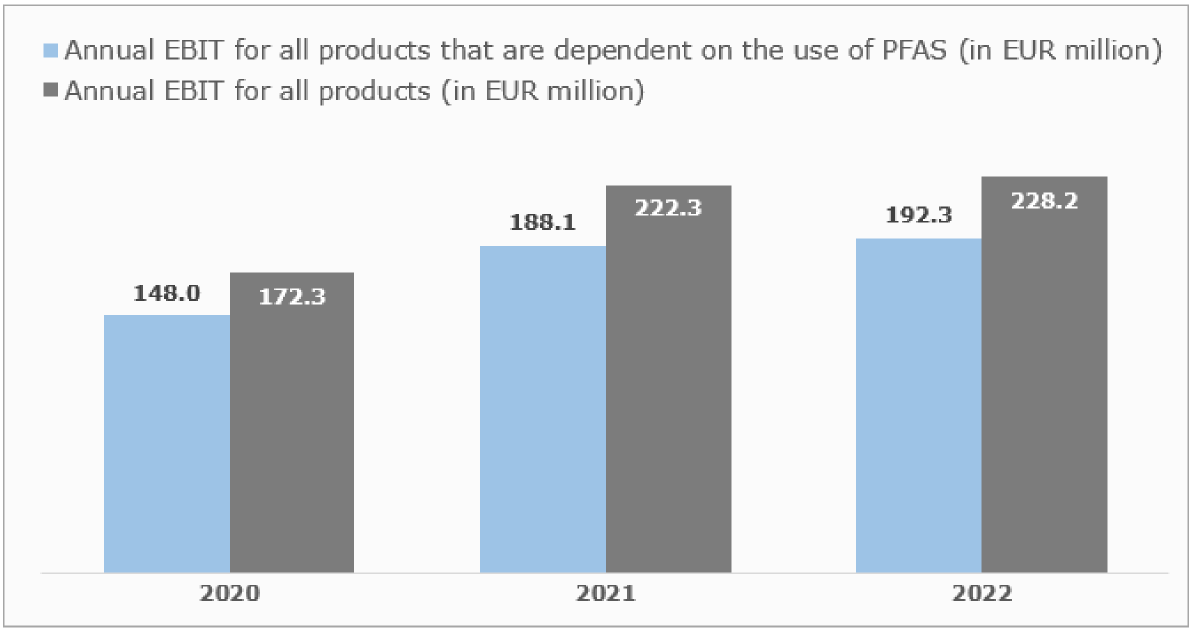

FIGURE 7: TOTAL EBIT AND PFAS-DEPENDENT EBIT GENERATED IN THE EEA BY WATER TREATMENT TECHNOLOGIES OF FIGAWA MEMBERS.

For water distribution, in 2022, 5,805 jobs were registered, attributed to figawa member companies employed in the EEA that are dependent on PFAS, i.e. their jobs rely on the production/sales of water distribution systems using fluoropolymer-based components.

2.1.2. Description of the function(s) of FPs and performance requirements of associated products

FPs are high-performance materials with unique properties that are needed for long-term applications. There is no single key function of FPs for the use in water supply, but a combination of several properties that are necessary to ensure the safe functioning of the system. Any alternative must be able to provide these functions simultaneously; otherwise, the safety of water supply products will be compromised. For example, sealing materials used in water supply must be chemically inert, otherwise the constant contact with water under a wide temperature and pressure range would lead to material aging and thus to the leaching of potentially hazardous substances from the sealing components into the water supply. However, at the same time, sealing materials must bring with them certain material properties, such as tensile strength and impact resistance, to ensure the leak tightness of the water supply network over a long lifetime duration. Hence, it is not possible to compromise on either property of the FPs.

In the following, the functions of FPs are described.

<u>Chemical resistance / inertness</u>

FPs show excellent chemical inertness towards several chemical groups. The high chemical stability of FPs is an absolute requirement. Due to its stability (chemical) aging is prevented, which could result in leaching of (potentially hazardous) degradation products into the (drinking) water.

In addition, the chemical inertness ensures the long lifetime of the FP-containing parts. As water supply systems are generally designed for a long service life (at least several decades) and there is limited access for maintenance and repair (e.g. in underground public water supply systems and wall installations). Therefore, components must function for a long time without being serviced.

There is currently no harmonised European legislation for products in contact with drinking water. The EU DWD is transposed into national legislations, which may vary in the detailed specifications. However, several member states have started an initiative in 2011 to align in the harmonization of tests for the hygienic suitability of products in contact with drinking-water (4MS Initiative) (Umwelt Bundesamt, 2023). Currently, France, Germany, the Netherlands and Denmark are part of this initiative and have set out evaluation criteria for organic materials (such as FPs) in contact with drinking water. In Germany, these evaluation criteria are described in the KTW-BWGL (Umweltbundesamt, 2020). Any organic material that comes into contact with drinking water may not:

- directly or indirectly reduce the protection of human health
- negatively impact the odour or flavour of water
- release substances into the drinking water in greater amounts than are considered unavoidable under the generally accepted rules of technology

However, the three objectives for the protection of drinking water do not only apply to Germany. The Attestation de Conformité Sanitaire (ACS, France) (Ministère de la Santé et de la Prévention, 2023), the Water Regulations Advisory Scheme (WRAS, United Kingdom) (WRAS, 2022) and the National Sanitation Foundation (NSF, USA) (NSF, 2017) follow the same objectives with their country specific evaluation criteria, to name just a few.

As described previously in section 1.2, the revised DWD came into force in January 2023 (EUR-Lex, 2020a) with an updated list of substances subject to monitoring and (lower) limit values, among others (e.g. in Annex III, Part B). In Annex III, Part B, Article 3, the DWD mentions 'Sum of PFAS' subject to monitoring, and lists specific PFAS substances. It must be highlighted that no FPs (e.g. PTFE) are mentioned here. This means that according to the DWD FPs are suitable for drinking water, as they do not pose any " (…) adverse effects of any contamination of water intended for human consumption by ensuring that it is wholesome and clean (…)" (Article 1 (EU) 2020/2184 (DWD)).

There are additional requirements for chemical inertness of water supply system components, which are defined in European technical standards for individual parts, such as:

- EN 806-2 for Specification for installations inside buildings conveying water for human consumption – Part 2: Design

Fouling resistance

(Drinking-) Water might contain small quantities of nutrients which support microbial growth, especially in combination with organic materials (Naismith, et al., 2017) [5], used in water supply systems (e.g. linings, sealings). This fouling of materials leads to:

- Formation of biofilm, which "poses a significant problem to the drinking water industry as a potential source of bacterial contamination, including pathogens, and, in many cases, also affecting the taste and odor of drinking water and promoting the corrosion of pipes" (Liu, et al., 2016)
- pathogens that might spread to the population *via* drinking water supply
- decreased material properties, such as low friction and material flexibility
- decreased leak tightness
- decreased product lifetime duration

FPs exhibit excellent fouling resistance, which ensures the safety of drinking water and that water supply systems have long service lives and do not require regular maintenance.

The 4MS Initiative described above also defines fouling resistance requirements. Any organic material in contact with drinking water may not enhance microbial growth while at the same time must not show biocidal properties or any other unusual suppression of microbial growth. This is also specified in standard EN 16421, among others, which describes testing of materials in contact with drinking water and their impact on microbial growth.

Pressure resistance

Water is supplied with a certain pressure. Certain standards define the pressure resistance of components used in water supply, such as:

[5] Support to the implementation and further development of the Drinking Water Directive (98/83/EC): Study on materials in contact with drinking water. Specific contract No. 07.0201/2015/716466/SFRA/ENV.C.2. Implementing Framework Service Contract ENV.D2/FRA/2012/0013. Umweltbundesamt, 2017.

- EN 200 for taps (recommended condition of use < 10 bar (static pressure), maximal condition of use < 5 bar (dynamic pressure)
- EN 817 for mechanical mixing valves (recommended condition of use < 10 bar (static pressure), maximal condition of use < 5 bar (dynamic pressure)
- EN 1111 for thermostatic mixing valves (recommended condition of use < 10 bar (static pressure), maximal condition of use < 5 bar (dynamic pressure)
- EN 1112 for shower-/spray heads (recommended condition of use < 3 bar (static pressure), maximal condition of use < 5 bar (dynamic pressure))

Temperature resistance

As water supply systems include the provision of hot water (e.g. in some cases up to 95 °C), any equipment must show some temperature resistance to ensure that other key functions are not detrimentally impacted. The temperature resistance for certain components is regulated by European standards, such as:

- EN 817 for mixing valves (recommended condition of use < 65 °C, maximal condition of use < 90 °C)
- EN 1111 for thermostatic mixing valves (recommended condition of use < 65 °C, maximal condition of use < 90 °C)
- EN 1112 for shower-/spray heads (recommended condition of use < 42 °C, maximal condition of use < 70 °C)
  - France NF077-07: homologation temperature resistance (and leak tightness) is tested in five cycles, where a cycle consists of 10 minutes cold water (20 °C) plus 10 minutes hot water (93 °C)
- EN 13828 for ball valves
- EN ISO 21003 for fittings, pipes and joints.

In certain cases, water supply systems are used for heating, for example for underfloor heating systems. In these cases, equipment is exposed to higher temperatures of 130 - 150 °C. The European standard EN ISO 15875 defines temperature resistance for axial compression sleeves used in cold and hot water installations.

Drinking water supply systems should even enable thermal disinfection by temperature >70°C for at least 3min (DVGW-Arbeitsblatt W 551).

Material properties

FPs combine properties, such as flexibility, durability, high tensile strength and impact resistance. This allows them to maintain their physical properties under a wide range of harsh conditions and over long maintenance intervals.

Leak tightness

FPs are used in sealing rings, gaskets, valves, pump heads and other components, which require a high level of leak tightness to avoid loss of water and malfunctioning of sensors and equipment, especially for a wide temperature- and pressure range.

For example, axial compression sleeves require materials with long-term elastic properties as well as high creep and relaxation resistance to maintain the high stress needed to ensure a safe and tight pipe connection at elevated temperatures of up to 100°C for a designated service life of 50 years with no decreased leak tightness.

The requirements for individual parts are defined in European standards, such as:

    - EN 200 for taps / faucets (homologation pressure resistance, no leakage at 25bar static pressure) France NF77-02: leak tightness is tested for alternating pressure stress with 200 cycles of pressure changes within 8 – 50 bar

- EN 817 for mechanically adjustable mixer (homologation pressure resistance, no leakage by 25bar)

    - France NF77-03: leak tightness is tested for alternating pressure stress with 200 cycles of pressure changes within 8 – 50 bar

- EN 1111 for thermostatic mixing valves (homologation pressure resistance, no leakage by 25bar)

    - France NF77-04: leak tightness is tested for alternating pressure stress with 200 cycles of pressure changes within 8 – 50 bar

- EN 1112 for shower-/spray heads (no leakage at 5 bar dynamic pressure

- EN 12266 for ball valves

Anti-friction / gliding properties

FPs have one of the lowest coefficients of friction providing them with excellent low-friction and gliding properties. Their gliding protects surfaces and components from friction and thus the risk of wear, which leads to decreased efficiency and product durability. This is being used in lubricant applications for water supply components, such as gliding elements, valves with sliding elements, and faucets with movable handles/taps. Gliding properties are an inherent condition for leak tightness, as specified by various standards, such as:

- EN 200 for taps / faucets
    - For control device: no deviation of operating force and no leakage during and after 70.000 control movements
    - For swivel spout: and no leakage during and after 80.000 swivel spout operations. For French homologation (NF077-02) 200.000 operations
- EN 817 for mechanically adjustable mixer
    - For control device: no deviation of operating force and no leakage during and after 70.000 control movements. For French homologation (NF077-03) 175.000 operations
    - For swivel spout: no leakage during and after 80.000 swivel spout operations. For French homologation (NF077-03) 200.000 operations
- EN 1111 for thermostatic mixing valves

- For on/off flow control device: no deviation of operating force and no leakage during and after 200.000 control movements. For French homologation (NF077-04) 500.000 operations
- For swivel spout: no leakage during and after 80.000 swivel spout operations. For French homologation (NF077-04) 200.000 operation.
- For thermostatic valve: no failure by scalding safety function after 50.000 operations

Strong adhesion

FPs are often used as lubricants in sanitary equipment, in gliding elements and in valves. Their strong adhesion to surfaces, such as metals, ceramics and plastic surfaces, ensures that lubricants remain in the intended components and that washing out, e.g. by water, is low. This enables the required long service life of water supply equipment parts.

Noise cancelling

The use of FPs in water supply systems, especially in sanitary equipment, leads to a reduction of noise. The acoustic behaviour of individual components is regulated by European standards, such as EN 200 for taps / faucets and EN 1112 for shower-/spray heads.

2.2. Efforts made to identify alternatives

2.2.1. Research and development

As depicted in Figure 5, companies providing equipment and technologies for water supply systems are located at the bottom half of the value chain. The figawa members of the water supply sector ('water supply system manufacturers') do not produce the individual components of water supply systems (e.g. sealing rings, gaskets, pipes, meters, lubricants, greases), but assemble the required components, which they purchase from a broad range of suppliers ('component manufacturers'), into the various water supply systems. Consequently, any research and development (R&D) on alternative substances and technologies must be coordinated and conducted with the component manufacturers and producers of (alternative) high-performance materials ('chemical suppliers').

The members of figawa, DGMT and AE are in communication with their suppliers regarding:

- Availability of alternative materials / components
- Testing of alternative materials / components lab-scale
- Testing of alternative materials / components during application
- Certification requirements

However, it must be highlighted that the majority of suppliers do not provide any alternative materials and technologies and it must be assumed that most producers of materials and component manufacturers are still at the early stages of R&D, if this has been started at all.

In summary, no suitable alternatives are available at this stage, as the high requirements for water supply systems, as requested by several regulations and standards, aggravates the search for suitable alternative materials / technologies.

2.2.2. Identification of alternatives

As stated in the previous section 2.2.1, R&D efforts for the identification of alternatives are still at a very early stage. Table 3 below provides an overview on potential alternatives that have been either mentioned by suppliers or have been taken from literature. However, available data is limited, as FPs are not classified and are considered PLCs, thus there has been no need in industry to assess alternatives. Therefore, the figawa members of this cluster aim to further identify alternatives and conduct tests for those that will be shortlisted based on availability, economic feasibility, safety considerations and an initial screening of technical feasibility. This will take time, as discussed in section 3.

It is not possible to identify one alternative that might be suitable for every product and component therein (see Table 3). An alternative such as Polyamide (PA) might be further investigated as an alternative for FPs used in axial compression sleeves but is not suitable for the use in sealings, where a certain impact resistance is needed. Hence, R&D efforts will take significant time to identify suitable alternatives for all components, which are needed for an efficient and safe water treatment. This is also reflected in section 3, where a hypothetical substitution timeline is discussed.

TABLE 3: OVERVIEW OF POTENTIAL ALTERNATIVES

Potential alternative	Potential application	Availability	Technical feasibility	Further considerations
Brass, standard	Axial compression sleeve	Available	Decreased chemical inertness, prone to corrosion Limited leak tightness Limited material flexibility	Brass contains lead (Pb), which is an SVHC due to its CMR properties
Brass, lead-free	Axial compression sleeve	Available	Decreased chemical inertness, prone to corrosion Limited leak tightness Limited material flexibility	Lead (Pb) content might exceed 0,1 % (w/w)
Calcium (complex) soap	Lubricant, grease for sanitary equipment	Available	Decreased adhesion on plastic surfaces Decreased temperature resistance (max. 65 °C) Decreased mechanical stability	Compatibility issues with plastics and elastomers Not suitable for application with high share rate and thin grease film Calcium Soap has been replaced by PTFE about 10 years ago because of this weakness and drinking

				water certification issues
Ethylene propylene diene monomer rubber (EPDM)	Pipes, piping systems	Available	No information yet available	
Ethylene propylene diene monomer rubber (EPDM)	Sealing materials	Available	Limited temperature resistance Limited chemical resistance Decreased UV resistance Reduced gliding properties Potentially feasible for treatment of seawater More R&D necessary to conclude technical feasibility	Shorter durability under certain conditions will result in additional costs (ring sealants made from EPDM show decreased durability in many applications)
Graphite	Lubricant, grease	Available	Limited chemical inertness Limited temperature and pressure resistance Limited material flexibility	Not suitable for use in drinking water (in accordance with DWD)
Molybdenum disulfide (MoS2)	Lubricant, grease	Available	Limited chemical inertness Limited temperature and pressure resistance	Not suitable for use in drinking water (in accordance with DWD)

			Limited material flexibility	
Nitrile butadiene rubber (NBR /HNBR)	Pipes, hoses	Available	Decreased chemical inertness Decreased temperature resistance (not suitable for hot water)	
Nitrile butadiene rubber (NBR /HNBR)	Sealing materials	Available	Decreased temperature resistance (not suitable for hot water)	
Polyamide (PA)	Axial compression sleeves	Available	Limited chemical inertness More R&D necessary to conclude technical feasibility	
Polyethylene (PE)	Valves	Available	Decreased chemical inertness Decreased leak tightness	
Polypropylene / polyvinylchloride (PP/PVC-U/PVC-C)	Pipes, piping systems	Available	No information yet available	Lack of high purity, not suitable for drinking water
Polyphenylsulfone (PPSU)	Axial compression sleeves	Available	Decreased chemical inertness	

			More R&D necessary to conclude technical feasibility	
Polysulfone (PSU)	Axial compression sleeves	Available	Decreased chemical inertness More R&D necessary to conclude technical feasibility	
Polyurethane (PU)	Sealing materials	Available	Decreased pressure resistance More R&D necessary to conclude technical feasibility	
Silicones	Pipes, hoses	Available	No information yet available	
Silicones	Sealing materials	Available	Reduced technical feasibility. More R&D necessary to conclude technical feasibility	

3. SUBSTITUTION TIMELINE

figawa primarily supports an exemption of FPs by way of a time-unlimited derogation for the applications relevant for its members (see section 2.1) or at least the longest derogation period to perform the research necessary to find and implement alternatives that meet our high standards, which would certainly require a minimum of 22 years.

In this section a hypothetical substitution is described, as there are currently no suitable alternatives available. It remains unclear if substitution will ever be possible for all water supply components. Nonetheless, the timeline needed for a potential substitution has been estimated. However, it must be highlighted that this is based on assumptions and estimations and serves as a justification why a derogation period is requested, which goes beyond the longest provided period of 12 years in the PFAS restriction proposal[6].

In addition, the estimated substitution timeline generalises all applications in water supply. In reality, all individual components must be assessed separately or at least in product category groups, as requirements and testing schemes differ. In some cases, a substitution may be successful, but in other cases, especially for components with direct contact to drinking water or for those in use under a wide temperature and pressure range, substitution is expected to fail.

Figure 8 and Table 4 describe the substitution timeline and the steps included therein. A total substitution timeline of 22 years is estimated if provision of spare parts is not included. When spare parts are also included, the substitution timeline extends to 28-33 years.

As described in section 2.1.1.1, the water supply system manufacturers are dependent on R&D and substitution efforts from component manufacturers and chemical suppliers. According to our information based on communication with our immediate suppliers, R&D for alternatives is still at a very early stage and some have not yet started the search for alternatives. Hence, in the substitution timeline the time needed for suppliers to identify and develop alternative materials and technologies is included as Phase I. We have estimated a best case where the supply chain will require seven years to provide multiple alternatives for different components in water supply processes. This timeline can be shorter for some applications / components and in other cases require substantially more than seven years.

Once a palette of alternative components becomes available, figawa members can then start their own R&D process and test the provided parts in-house for water supply applications (Phase II). In the case that alternatives prove to be successful, the next Phase (Phase III) entails product re-designs to adjust for the new components. The adjusted products are then subject to further testing at customer sites to ensure that the components are suitable for actual use conditions and for longer periods. If the alternative products fulfil the customers' requirements, global regulatory and technical requirements, as well as adjustment of production lines must then be addressed in Phase IV. This could

[6] For the socio-economic impact assessment, a time-unlimited derogation period has been used for the calculations

mean that certain technical standards and/or customer requirements might need to be changed and adjusted or in other cases, certain products are subject to global re-certification. This process will be costly and time-consuming. Upon successful re-certification and regulatory approvals, products containing alternative components can then be gradually included into the product portfolio and introduced to the market (Phase V). To allow customers to gradually change to the new products, a transition phase (Phase VI) is necessary to complete substitution.

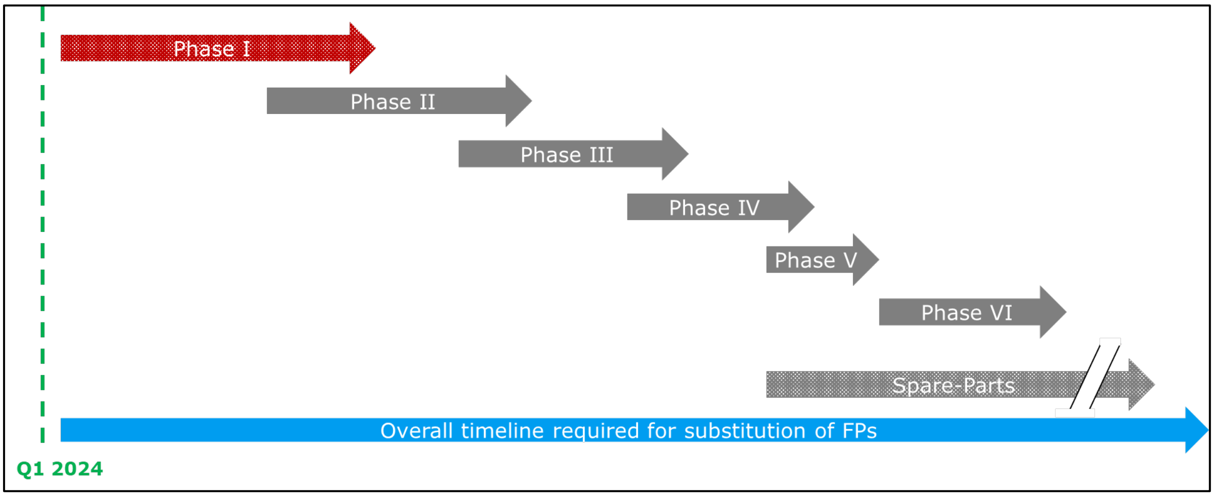

FIGURE 8: OVERVIEW OF SUBSTITUTION PHASES

TABLE 4: DESCRIPTION OF SUBSTITUTION PHASES

Phase	**Description**	**Period (in years)**
I	R&D of suppliers: Identification, testing and commercialisation of alternative materials and technologies by chemical suppliers and component manufacturers	7
II	R&D of potential alternatives (in-house / with suppliers) Testing of potential alternatives (in-house / with testing facilities)	6 (2 years overlap with Phase I)
III	Product re-design and readjustments External R&D and testing of potential alternatives (at customers) Large-scale tests	4 (1 year overlap with Phase II)
IV	Global product registration, (re-)certification, drinking water approvals, customer qualification Changes to existing production lines and/or setting up new production lines	4 (1 year overlap with Phase III)

V	Inclusion of alternative products into market / addition to product portfolio	2 (1 year overlap with Phase IV)
VI	Transition phase to 100 % substitution	4
Spare-parts	Availability of FP-containing spare parts	10 - 15 (starting from Phase V)
Total substitution timeline without spare-parts (in years)		**22**
Total substitution timeline with spare-parts (in years)		**28 - 33**

4. SOCIO-ECONOMIC ANALYSIS

This chapter compares the environmental risks associated with continued use (where emissions are used as a proxy) of FPs with the corresponding socio-economic benefits to the EEA society. The consequent sections draw upon the analysis of the chemical safety report and input provided by figawa members.

4.1. Emissions as a proxy for risk

figawa members utilize FPs for the safe and durable operation of their products, including water supply and distribution. These members primarily engage in assembling end-products, and emissions from the manufacturing phase are considered controlled and negligible. During the intended use of end-products, emissions are also considered controlled due to the chemical stability and durability of FPs. Potential emissions may arise from wear-and-tear or the use of lubricants, although these are estimated to be small.

Data regarding emissions from waste treatment, such as incineration, are limited, but it is expected that more information will become available in the future. Both figawa and its members support the need for more data to establish appropriate regulatory approaches. Manufacturers of FPs are already taking steps to reduce emissions of hazardous PFAS, such as phasing out the use of fluorosurfactants in production (Solvay, 2023) and the development of non-fluorinated polymerization aids (Gujarat Fluorochemicals, 2022).

In conclusion, figawa members produce essential products for water treatment, and heating and cooling systems, with a low concentration of FPs.

4.2. Restriction scenario

According to current expectations, a potential PFAS restriction assumes entry into force (EiF) mid-2025, with the ban being enforced in 2027. In this sense, two restriction options (ROs) have been proposed (ECHA, 2023):

- RO1: A full ban with no derogations and a transition period of 18 months
- RO2: A full ban with use-specific time-limited derogations (18 month-transition period plus either a 5- or a 12-year derogation period)

Notably, as stated in the previously published restriction proposal, RO2 is considered to be the preferred option by the submitting Member States (ECHA, 2023).

As previously mentioned in section 2.1, no substances of concern are used for the manufacturing of components containing FPs used in public infrastructure, water distribution systems in buildings, and water measurement systems within the scope of the current report. Given that despite their persistence, FPs satisfy the widely accepted assessment criteria to be considered as "polymers of low concern" (Henry, et al., 2018) whilst the absence of PFAS-free alternatives in this regard, figawa members commissioning the current report support an exemption of FPs by way of a time-unlimited derogation for the water distribution applications or at least the longest derogation period to perform the research necessary to find and implement alternatives that meet high standards, which would certainly require more than 20 years.

To assess the socio-economic impacts on the EEA society that would result in a restriction scenario in which no such time-unlimited derogation would be granted, sections 4.2.1 through 4.2.3 introduce the business reactions of the different actors in the value chain (see section 2.1.1.1) and the associated consequences that would become applicable in such a scenario.

4.2.1. Business reactions of upstream stakeholders in the value chain

In a hypothetical scenario where FPs are not exempted from PFAS restrictions, significant consequences would be observed for fluoropolymer producers, processors, and component manufacturers. The supply chain would be disrupted, as fluoropolymer producers and processors could no longer provide their products to component manufacturers in scope of this assessment. Consequently, this disruption may lead to a complete closure of associated business activities for the upstream stakeholders.

Consequently, this disturbance could instigate a cessation of correlated business activities for upstream stakeholders. The intensity of the disruption might potentially lead some organizations towards a complete termination of their operations within the EEA, particularly if their non-fluoropolymer reliant production activities fail to maintain enduring business feasibility. This scenario appears accurate for specific chemical conglomerates, which aim to relocate their production beyond the EEA, investing in novel plants and technologies, principally in the US and China. These countries will benefit by challenging foreign direct investments in Germany. For instance, the world's preeminent chemical corporation, based in Germany, is presently constructing its most substantial petrochemical complex in China and intends to permanently curtail its operations in the EEA.

While this scenario seems feasible for large-scale enterprises, small and medium-sized firms find themselves at a lack of additional resources for such undertakings and would consequently cease their business operations in the EEA.

Resultingly, foregone profits and job losses are anticipated for these upstream stakeholders. In cases where a complete shutdown becomes necessary, additional one-off investment costs for dismantling facilities, clean-up and remediation will become necessary.

4.2.2. Business reactions of manufacturers of water distribution technologies (OEMs)

After observing the responses of upstream stakeholders to the restriction scenario, manufacturers of water distribution systems/equipment are expected to encounter substantial difficulties. The effects on these OEMs will be complex, as they depend on factors like the company's size, business model, and scale of operations. Larger companies in this sector may confront the challenging situation of having to completely shut down their European manufacturing facilities, particularly if their product portfolio heavily relies on fluoropolymer-based components. This outcome would not only result in a loss of producer surplus but also entail significant capital expenses for dismantling the facilities, potentially leading to unemployment.

In contrast, certain original equipment manufacturers (OEMs), particularly those with a global presence, may contemplate relocating their production operations outside of EEA to sustain their supply to other regions. However, this course of action presents its own set of challenges. The relocation process would entail substantial requalification expenses to establish new facilities. Moreover, the limited timeframe specified until the EiF is implemented renders this option infeasible for some OEMs. Even for those for whom relocation may be feasible, it has the potential to disrupt the entire downstream supply chain due to extended lead times.

The relocation option may not be financially viable for many small and medium-sized enterprises (SMEs) due to their constrained resources, compelling them to entirely cease their operations. Consequently, such a scenario would not only result in losses of producer surplus but also lead to substantial job losses, potentially causing adverse effects on the European workforce and economy. This in turn also hinders the progress to achieve EU's Green Deal goals, primarily concerning climate neutrality, promoting clean energy, ensuring sustainable mobility and circular economy.

In the absence of alternatives, the use of substitute materials with limited performance might be considered by few OEMs to remain competitive. This could however imply massive changes in the complete installation and framework of pipes and fittings to achieve some level of functionality. Before complete systems can be implemented, a supply disruption is inevitable. Please refer to section 2.1.1.1 for examples of inclusion of fluoropolymer components in critical infrastructure in the overall supply chain.

Such changes would have significant impacts, including foregone profits and job losses for OEMs in the EEA. Additionally, dismantling facilities and adopting alternative materials may lead to one-off investment costs, which would have broader societal repercussions within the EEA.

4.2.3. Business reactions of downstream stakeholders in the value chain

The consequences of a PFAS restriction on the upstream supply chain would indirectly impact the EEA society as upstream job losses and economic repercussions ripple through the affected industries. Beyond the immediate impacts on producers and OEMs, the consequences of a PFAS ban would extend across the sanitary industry including 50,000 plumbers/installers using piping systems for water installations in buildings, other OEMs involved in assembly of parts/components and public utilities/heating applications.

With the restriction on FPs whilst an absence of alternatives, these private and public sector applications in the sanitary industry would face significant challenges. The potential negative spillover effects due to lack of repair and maintenance of existing equipment and inability to install new equipment would not only impact the sanitation sector itself but also disrupt related supply chains and industrial processes. It could lead to delays in construction projects, increased maintenance costs, and potential disruptions in water distribution systems, affecting public health and overall infrastructure reliability. Additional deaths and illnesses are hard to estimate if, for example, hospitals and nursing homes face additional difficulties during a serious crisis such as generated by COVID-19 and are not able to repair their central water supply units due to the unavailability or scarceness of components.

4.3. Impact assessment

The lack of a time-unlimited derogation for the use of FPs for water distribution systems and technologies in the context of the PFAS restriction would generate consequences for several stakeholders along the specific value chain, thus further impacting the entire EEA society. The current section addresses the resulting impacts, either in a monetized form – whenever quantitative data was available – or in a qualitative manner:

- **Broader societal impacts**
- **Socio-economic impacts**
    - Foregone profits at the level of manufacturers of water distribution systems and technologies *(monetization available)*
    - Further foregone profits at the level of fluoropolymer manufacturers and processors as well as component manufacturers
    - Job losses at the level of water distribution system producers *(monetization available)*
    - Additional one-off capital costs for replacing existing water distribution systems *(monetization available)*
    - Additional one-off investment costs for Research & Development of alternatives
    - Increased operating costs for affected industrial and public sites

For the current impact assessment, the PFAS restriction is assumed, for simplicity, to enter into force mid-2025. While accounting for an 18-month transition period, the impact realization period is considered to begin in 2027. The base year of the analysis is 2025 and the impact assessment period was set to a timeframe between 30 and 45 years (associated with the persistence of PFAS in the baseline scenario), in agreement with the impact assessment period considered in the PFAS restriction proposal (ECHA, 2023). To monetize the respective impacts, a social discount rate of 3 % was consistently used throughout the assessment when deriving the net present value (NPV) or the annualized value for any given amount, in accordance with the latest guideline from ECHA on socio-economic analysis (ECHA, 2011).

For the applicable impact categories mentioned above, not all impacts have been monetised in the following sections. The valuation of impacts and extrapolation thereof has remained difficult due to constraints in data availability for the entire sector and all stakeholders. Data, wherever applicable for OEMs, was obtained by some figawa members for exemplary valuation which must be seen as a bare minimum indication of socio-economic estimates at least at the OEM level in the supply chain (see Figure 5). Impacts associated with other stakeholders in the supply chain are only qualitatively explained.

4.3.1. Social impacts

With respect to the societal consequences incurred in the EEA in case of the considered impact assessment scenario, sections 4.3.1.1 and 4.3.1.2 provide an overview over the effects related to unemployment as well as population health.

4.3.1.1. Broader societal impacts

As previously explained in section 4.2.34.2.3, a PFAS restriction covering water distribution systems using fluoropolymer-based components would severely reduce the security of supply of water, both drinking water and e.g., the wastewater system, due to the reasons explained below.

Replacement of existing components

Replacement of existing stock in the market is driven by both the expansion of the distribution network and the building stock, and by the product life cycles. The annual rate of replacement of existing pipe in the public distribution network is currently between 0.5 to 1.2 % of the estimated 5 million km in the network, totalling approximately 25,000 to 50,000 km per year. Service pipe replacement is around 1 % per year with roughly 20,000 km of plastic service pipe installed annually. Plumbing pipe replacement in private ownership is difficult to assess but is estimated at a 1 % per year replacement rate. Taps, with an average in service life of up to 15 years, will potentially be replaced twice between now and 2050, as will other mechanical devices subject to wear such as pumps and meters. This replacement market is set to grow as the expanded networks and house building of the past century feeds through into requiring repair (Umweltbundesamt GmbH, 2017). Each of these replacements are assumed to be accompanied by replacements of FP based components that are used in the distribution systems.

If PFAS restrictions are enforced, current fluoropolymer-containing components would need to be replaced with alternative materials. If alternatives are available for some applications, the process of testing, and implementing suitable substitutes could be time-consuming and resource intensive. This transitional period may cause temporary disruptions in water supply to various infrastructures. On the other hand, FPs are known for their durability, resistance to chemical degradation, and ability to withstand high temperatures and pressures wherein; if alternative materials do not possess the same properties, the new components may show increased wear and tear, unexpected failure rates, or decreased lifespan. Such scenarios can result in water supply disruptions due to necessary maintenance, repairs, or component replacements.

Supply of drinking water

The EU market for new drinking water installations consists of three components:

- new extensions to the existing public water distribution network for connecting existing and new properties, enhancing interconnectivity, or incorporating new water sources;
- plumbing in new buildings and extensions to existing structures; and

- replacing current pipes, fittings, and accessories in the public distribution network and building plumbing system, either when they reach the end of their service life or for equipment upgrades before the end of service life.

As the EU population stabilizes during this century, reaching a peak of 526 million by 2050 and falling to 519.8 million by 2075, a change in demand for new buildings and public network extensions is expected (Umweltbundesamt GmbH, 2017). In 2012, the EU had 236 million existing dwellings, and approximately 1.6 million new dwellings were completed. This growth is projected to result in an increase of about 9.5 % in the dwelling stock by 2030 and 26 % by 2050. Connection rates to public networks vary among EU Member States, with Eastern European countries generally having lower rates. As new developments emerge, the market for new service pipes, plumbing systems, and other water-related installations are expected to grow (Umweltbundesamt GmbH, 2017). A lack of the FP based components used in these distribution systems threatens the continuous supply and distribution of drinking water throughout the European society affecting some Member States more than the others.

Water contamination risks

Fluoropolymer materials used in water distribution systems are inert, non-reactive, and resistant to biofilm formation. In contrast, alternative materials might be more susceptible to biofilm growth or chemical leaching, which could compromise the water quality. An increase in potential contamination risks can lead to interruptions in water supply if systems need to be shut down for cleaning, maintenance, or analysis of water quality.

Whilst the sanitary market including plumbers/installers would be most affected by the restriction, existing infrastructure encompassing a wide range of crucial societal applications will be heavily impacted due to hindrances in maintenance and repair activities and new infrastructures may also experience delays in installations. In case customer systems and facilities could not be completed, a massive loss of profits for these customers would occur. Product lifespans and reliability, i.e., long term usability and sustainability of the affected products, would be reduced, which implies that repairs, maintenance, and replacement would be increased. Quality and hygiene of drinking water would be deteriorated, and heating may be interrupted more frequently. Direct customers and further downstream users (plumbing and installation companies) would lose the market, e.g., for faucets, showers and further sanitary and heating applications, in the EEA.

While the impacts demonstrated above are applicable for all infrastructures irrespective of the industry sector, the impacts of water supply disruptions in clinics and hospitals caused by PFAS restrictions in water distribution components where public health implications play a critical role are especially highlighted below:

- Infection control: Clinics and hospitals rely on a consistent water supply to maintain hygiene, sterility, and proper sanitation in their facilities. Water supply disruptions can compromise cleanliness, increasing the risk of hospital-acquired infections (HAIs) and cross-contamination among patients, staff, and visitors. For instance, improper hand-washing due to limited water access can promote the spread of harmful bacteria and viruses.

- In addition to clinics and hospitals, other institutions such as old people's homes and children's nurseries require strict sanitation standards to protect vulnerable populations from infections and health complications.

- Medical procedures and equipment: Water is necessary for various medical procedures, such as surgical operations, dialysis treatments, and wound cleansing. Unavailability or compromised quality of water can cause delays in these procedures, put patients' lives at risk, or lead to complications during treatment. Additionally, water is essential for cleaning, sterilizing, and reprocessing medical instruments and equipment, ensuring they remain safe and uncontaminated for patients' use.

- Healthcare facilities' operation: Water supply disruptions to clinics and hospitals may impact cooling and heating systems, food preparation, and laundry services. These disruptions can compromise the overall functioning of healthcare facilities, affecting not only patients but also medical professionals, support staff, and visitors.

Although the examples presented above only emphasise the impacts on public health, a continuous supply of treated water within the whole installation and heating systems in buildings in all spheres of the society should be anticipated to be impacted due to the PFAS restriction without the requested derogation period. Rather than addressing the issue on a case-by-case basis, an industry-wide approach that leads to an exemption for the entire water treatment sector, including components and tools required for constructing such systems, will help address the risks posed by PFAS restrictions in water distribution systems across various sectors. This approach will not only protect public health but also facilitate uniform regulatory compliance and reduce the risk of liability associated with PFAS contamination across all facilities that depend on safe water distribution systems and heating systems.

Despite these consequences being of major importance for the EEA society, these aspects are only mentioned here at a qualitative level, due to limitations concerning available data.

4.3.1.2. Social cost of unemployment

A PFAS restriction without the requested derogation for the use of FPs in water distribution systems from the PFAS restriction would result in job losses at manufacturers of such technologies as well as the level of upstream stakeholders in the value chain. The social cost associated with these job losses that would be incurred by the EEA society in such an impact assessment scenario is monetized in this section.

Methodology

According to a valuation paper commissioned by ECHA (Dubourg, 2016), the social cost of unemployment associated with job losses can be evaluated based on the following components:

- The value of lost output/wages during the period of unemployment

- The cost of acquiring a new job

- Recruitment costs
- Scarring costs (i.e., the impact of being made unemployed on future earnings and employment possibilities)
- The value of leisure time during the period of unemployment

The latter component is defined as a negative cost (i.e., a benefit) of unemployment. As such, it is subtracted from the total cost resulting from the first four components.

For the current assessment, the figures from the aforementioned paper have been updated with recent data representative for 27 EU countries, by using 2021 estimates for wages (Rogers & Marques, 2021) and Eurostat 2021 data on the duration of unemployment (Eurostat, 2022a). The figures for average wages were projected to the year 2027 when they are assumed to accrue by using an average Labour Cost Index (LCI) of 2.425 % based on the LCI values registered between 2016 and 2021 and provided by Eurostat (Eurostat, 2022b). Notably, although estimations for wages are already available for 2022, for consistency with the data on unemployment duration, 2021 data has been used.

This approach leads to a value of the costs associated with losing one job of 98,151 Euros in 2027, which is comparable to the population-weighted average for EU-27 reported in the aforementioned valuation paper (Dubourg, 2016). By multiplying the number of job losses expected in the EEA in such an impact assessment scenario with the costs associated with losing one job, the total social costs incurred by the EEA society could be computed. Notably, for the evaluation of the number of job losses in such a scenario, the following additional assumptions were applied:

- It is estimated that 5,772 jobs dependent on the production/sales of water distribution systems relying on FPs would be lost at manufacturers of such technologies, which is nearly all of the PFAS-related jobs in total (5,805) estimated at figawa members.
- The research conducted on materials in contact with drinking water (Umweltbundesamt GmbH, 2017) also suggests that the EU employs over 100,000 people for producing products used in contact with drinking water, generating annual sales of up to 40 billion Euros. Assuming that an additional 10 % of these jobs could be lost in the cluster of water distribution systems, e.g., in the upstream value chain, such as at component manufacturers, this would result in a further loss of 10,000 jobs or an additional factor of 1.7 times.

Results

At the level of manufacturers of water distribution systems relying on FPs, it is estimated that about 5,772 jobs would be lost in the EEA in an impact assessment scenario. Additionally, based on the above assumptions, additional job losses of about 10,000 employees across the supply chain is estimated to be lost in the EEA. A total of 15,772 job dismissals would consequently result in 1,459.17 million Euros in terms of social costs for the EEA society (NPV 2025). The value is equivalent to an annualized amount of 74.45 million Euros per year of additional social costs considering a 30-year impact assessment period. This translates to an annualized amount of 59.51 million Euros over a 45-year period.

TABLE 5: THE SOCIAL COST OF UNEMPLOYMENT INCURRED BY THE EEA SOCIETY IN CASE OF THE IMPACT ASSESSMENT SCENARIO DUE TO JOB LOSSES ACROSS THE SUPPLY CHAIN

Socio-economic impact factor	**Value [million Euros]**
The social cost associated with all job losses at manufacturers of water distribution systems in 2027	566.53
The social cost associated with other job losses across the supply chain in 2027	981.51
Total social cost of unemployment across the supply chain	1,548.04
Net present value in the base year (NPV 2025)	1,459.17
Annualized amount over a period of 30 years	74.45
Annualized amount over a period of 45 years	59.51

It is important to acknowledge that the information provided above solely represents a subset of figawa members and incorporates a minimal assumption for stakeholders in the upstream supply chain. Consequently, it should be emphasized that **these figures do not offer a comprehensive portrayal of the entire sector's impacts**. In reality, considering all stakeholders, the overall impacts would likely be considerably larger

4.3.2. Economic impacts

The absence of a time-unlimited derogation for the use of FPs in water distribution systems in the context of the PFAS restriction would generate several economic impacts for the different stakeholders in the value chain described in section 2.1.1.1. This section will cover the following impact categories incurred in the EEA:

- Producer surplus losses
- Additional one-off investment costs
- Additional operating costs

4.3.2.1. Producer surplus losses

As already explained in section 4.2.24.2, in a restriction, all stakeholders whose businesses depend on these substances would be affected.

Although fluoropolymer producers and processors as well as manufacturers of components for water distribution systems would experience substantial foregone profits in such a restriction scenario (see section 4.24.2.1), for the current impact assessment these effects remain unquantified due to a lack of appropriate data. Given the current data availability, to maintain a conservative approach, the focus of this section is limited to the monetization of the foregone profits incurred by manufacturers of water distribution systems and technologies.

Methodology

According to a guideline published by ECHA on evaluating losses in producer surplus, these foregone profits are the result of premature retirement of productive capital assets and represent losses to the EEA society (ECHA, 2021a). Based on this methodology, the foregone profits can be accounted for as producer surplus losses for the remaining service lifetime of capital assets at the point of decision making. The remaining service lifetime is based on the period of time needed by competitors to take over the respective market share dependent on the substance use (ECHA, 2021a).

Consequently, the following assumptions were made to monetize these producer surplus losses within the EEA due to foregone profits:

- To maintain a conservative approach and in line with the above-mentioned guideline (ECHA, 2021a), foregone profits were considered to accrue over a period of 2 years only.
- The valuation of producer surplus losses uses EBIT as a proxy. EBIT losses have been considered to start occurring in 2027.
- It was assumed that all EBIT dependent on the sales of water distribution systems relying on FPs would be lost by the respective manufacturers (see baseline financial information in section 2.1.1.2. To remain conservative, it was also assumed that the annual loss of EBIT should not surpass the EBIT attributed to the total PFAS use in this sector, which was the case for several member companies.
- The EBIT values of the year 2022 EBIT were considered a conservative proxy for the EBIT values expected to be registered in 2027, i.e. potential growth rates between 2022 and 2027 have not been taken into account.

Results

No time-unlimited derogation for the use of FPs in water distribution systems would lead to foregone profits of 357.24 million Euros (NPV 2025) for the EEA society. Notably, this amount only accounts for the producer surplus losses incurred in such an impact assessment at the level of the water distribution systems. Annualized over a 30-year impact assessment period, this amount is equivalent to 18.23 million Euros in terms of losses for the EEA society per year. Considering a 45-year period, the annualized costs are 14.57 million Euros per year.

TABLE 6: FOREGONE PROFITS AT MANUFACTURERS OF WATER DISTRIBUTION SYSTEMS RELYING ON THE USE OF FPS IN CASE OF THE IMPACT ASSESSMENT SCENARIO.

Socio-economic impact factor	**Value [million Euros]**
Foregone profits per year at manufacturers of water	192.30

distribution systems in the years 2027 and 2028	
Net present value in the base year (NPV 2025)	357.24
Annualized amount over a period of 30 years	18.23
Annualized amount over a period of 45 years	14.57

As there are other OEMs of water treatment systems in the EEA besides figawa members that provided relevant data for demonstration of producer surplus losses in the EEA, **it has to be noted that this is an underestimation of the lost profits on the real sector within the EEA**. As described in section 2.1.1.1, the study performed by UBA estimated that more than 5,000 companies within the EU are involved in producing finished products used in contact with drinking water. A smaller share of these companies is expected to belong to the sector of water treatment technologies, another and probably larger share to the sector of water distributions systems.

4.3.2.2. Additional one-off investment costs

In section 4.2.34.2.3 it has been already outlined that, in the absence of a time-unlimited derogation from the PFAS restriction for the use of FPs for water distribution systems, such existing private and public installations would face a series of challenges. The additional capital costs arising as a result of e.g., replacements of installations are estimated in the current section.

Methodology

As already mentioned in section 2.1.1.14.2.3, the sanitary industry including 50,000 plumbers/installers using piping systems for water installations in buildings, other OEMs involved in assembly of parts/components and public utilities/heating applications would be affected by the restriction on FPs due to an absence of alternatives, and private and public sector applications in the sanitary industry would face significant challenges.

In the following, the total one-off investment costs are based on estimations of the figawa member companies for their own companies only. They estimated e.g., costs for decommissioning and replacement of all machines and systems, conversion and change of systems in the assembly, development costs for testing new materials, and other investment cost categories, of 33.55 million Euros in 2027.

Results

Overall, a lack of a time-unlimited derogation from the PFAS restriction for the use of FPs in water distribution systems would result in additional capital costs for the figawa member companies of 31.62 million Euros (NPV 2025). This is equivalent to an annualized amount of 1.61 million Euros in terms of additional costs for the EEA society per year over a 30-year impact assessment period. Over a 45-year period, the amount is equivalent to 1.29 million Euros per year.

TABLE 7: ADDITIONAL CAPITAL COSTS FOR DECOMMISSIONING/REPLACING EXISTING WATER DISTRIBUTION SYSTEMS AND EQUIPMENT IN THE EEA IN CASE OF THE IMPACT ASSESSMENT SCENARIO.

Socio-economic impact factor	Value [million Euros]
Additional one-off capital costs for in the EEA in 2027	33.55
Net present value in the base year (NPV 2025)	31.62
Annualized amount over a period of 30 years	1.61
Annualized amount over a period of 45 years	1.29

It should be noted that the additional capital costs presented here underestimate the actual implications for the EEA water distribution sector. This is because, besides figawa members who provided data on additional capital costs for decommissioning existing water distribution systems, there are other OEMs and corresponding additional public and private installations in the EEA that have not been considered (see section 2.1.1.1 for further details on types of stakeholders under this sector).

4.3.2.3. Additional operational costs

In case no time-unlimited derogation from the PFAS restriction would be granted for the use of FPs in water distribution systems and in the absence of viable alternatives, industrial processes are expected to suffer from delays, increased maintenance costs, and potential disruptions in water distribution systems. This is mainly due to the lack of maintenance and repair of damaged components and inability to install new systems depending on components using FPs. Due to lack of appropriate data for a quantitative assessment, these impacts are however only qualitatively described at this stage and are not accounted for in the monetization of impacts in this report.

4.3.3. Distributional impacts

In section 4.3.1.24.2, it was already mentioned that a PFAS restriction covering water distribution systems using fluoropolymer-based components would result in several jobs to be lost in the EEA throughout the value chain of such technologies. As a result of such job losses, significant severance payments would be incurred by EEA companies where dismissals would become necessary. Nevertheless, such payments are considered distributional impacts and are not counted towards the overall monetized costs projected in this impact assessment.

As a further remark regarding distributional impacts, it should be noted that the socio-economic impacts discussed in the current report would tend to be distributed throughout the EEA, with several countries being impacted to different extents. In particular, the countries and industrial regions in which manufacturers of water distribution systems and technologies are based would be most affected from the perspective of producer surplus and job losses. Meanwhile, increasing water prices may affect especially Member States in Southern and South-Eastern parts of Europe more than the others.

4.3.4. Compilation of socio-economic impacts

Table 8 provides a summary overview of the socio-economic impacts that would be incurred in the EEA in case there would be no time-unlimited derogation from the PFAS restriction for the use of FPs in water distribution systems and technologies. Overall, the corresponding monetized costs sum up to a total of **1,848.03 million Euros (NPV 2025).** The value is equivalent to an annualized amount of 94.29 million Euros per year of additional social costs considering a 30-year impact assessment period. This translates to an annualized amount of **75.37 million Euros per year over a 45-year period**. These values do not account for qualitatively described impacts, such as further health and market effects.

TABLE 8: SUMMARY OF SOCIO-ECONOMIC IMPACTS INCURRED IN THE EEA IN CASE OF THE IMPACT ASSESSMENT SCENARIO.

Description of major impacts	**Monetised/quantitatively assessed/qualitatively assessed impacts**
1. Monetised impacts	**Value in million Euros [per year over 30 years] [per year over 45 years] [overall as NPV_{2025}]**
Foregone profits at manufacturers of water distribution systems	**[18.23] [14.57] [357.24]**
Additional one-off capital costs for decommissioning/replacing existing water distribution systems and machines (NPV 2025)	**[1.61] [1.29] [31.62]**
The social cost associated with all job losses at manufacturers of water distribution systems	**[74.45] [59.51] [1,459.17]**
Sum of monetised impacts	**[94.29] [75.37] [1,848.03]**
2. Additional qualitatively assessed impacts	
See section 4.3.1.14.3.1.1 on welfare losses to the society	Not monetised

5. Limitations and uncertainties

While a conservative approach was taken throughout the current assessment, there are several data limitations in the analysis which led to an underestimation of the monetized socio-economic impacts summarized in Chapter 4.

As previously emphasized in sections 4.3.2.1, 4.3.2.2 and 4.3.1.2, appropriate data for the monetization of impacts (foregone profits, one-off costs and costs of unemployment) was only available in the context of the German figawa member companies relying on the use of FPs when producing water distribution systems. No reliable data coverage for other

EU member states or even stakeholders falling under the scope of the current report could be made available; other estimates available do not exactly refer to the same sector. Therefore, the results can be regarded as exemplary for the EEA rather than area wide.

Furthermore, to maintain a conservative approach and due to lack of appropriate estimates, no foregone profits occurring upstream in the value chain (e.g., at fluoropolymer producers and processors, component manufacturers) were accounted towards the monetized impacts in this report. These effects are nonetheless expected to be large, thus leading to an underestimation of the results presented in section 4.3.44.3.4.

Finally, there was no data available for the monetization of further impacts on the EEA society associated with a lack of a time-unlimited derogation for the use of FPs in water distribution systems. In this sense, effects related to the increased environmental footprint, reduced security of water supply and associated increased risk for all potentially affected public and private infrastructure could only be evaluated qualitatively.

6. CONCLUSION

In summary, the ramifications of a PFAS restriction, as determined by the socioeconomic evaluation, amount to approximately 1,848.03 million Euros (NPV 2025) or 75.37 million Euros per annum over a 45-year timespan.

Although the assessment solely incorporates contributions from figawa members included in the scope of this request, it is crucial to underscore the far-reaching implications of such a restriction, in the absence of the desired exemption, upon the entirety of the EEA society. This is particularly noteworthy as the repercussions of the restriction are likely to create a ripple effect, touching upon private households, industrial infrastructure, and public utilities alike. In the absence of sufficient time to identify, test, and implement viable substitutes, disruptions stemming from hindered maintenance and repair procedures and installations of new systems are inevitably foreseen to cause supply chain disturbances.

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