Project Report for: European Bank for Reconstruction and Development (EBRD)

Technology Guide Development for Sound POPs Management in the Mediterranean Region (Balkans, SEMED and Türkiye)

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Executive Summary

Persistent Organic Pollutants (POPs) are the name given to a large number of organic chemical substances, which have been shown to have a significant impact on the environment and human health. Many POPs can be transported by wind and water, meaning that those generated in one country may affect people, animals, and plants far from where they are used and released. They persist for long periods of time in the environment and can accumulate and pass from one species to the next through the food chain. The characteristics of POPs, notably their long environmental lifetime and the fact that they can have impacts far from where they were produced, mean that countries need to work together for their elimination. The 2001 Stockholm Convention is a global treaty aiming to protect human health and the environment from the effects of POPs and focuses on eliminating or reducing their release.

The European Bank for Reconstruction and Development (EBRD) commissioned Earth Active to undertake research to identify and assess off-the-shelf technologies for the responsible management of four groups of POPs in eight countries across the Mediterranean region, namely Albania, Bosnia and Herzegovina, Egypt, Lebanon, Montenegro, Morocco, Tunisia, and Türkiye. The assignment supports the EBRD's Environmental Technology Transfer Programme (ENVITECC), funded by the Global Environment Facility under the Mediterranean Sea Programme: Enhancing Environmental Security (MedProgramme) (2020-2024) and is aligned with the bank's Green Economy Transition (GET) approach. Ultimately, it is intended that suitable technologies and POPs-free materials identified as part of this assignment will be made available in the EBRD's Green Technology Selector, which is a global shopping-style online platform launched by the EBRD in 2018 that connects vendors of the best green technologies with forward-thinking business and homeowners.

The assignment focuses on the following four groups of POPs:

- **PCBs** – Polychlorinated Biphenyls – used in a large number of industrial applications, in particular as dielectric (insulating) fluids in transformers and capacitors
- **PFAS / PFOS** – Per / poly fluoroalkyl substances – used in fire-fighting foams, electric and electronic equipment and as surface treatment agents
- **HBCD** – Hexabromocyclododecane – mainly used as a flame-retardant additive and thermal insulation in polystyrene materials in the building industry as well as in upholstered furniture and packaging materials
- **SCCP** – Short-chain chlorinated paraffins – used in metalworking and PVC processing and as a plasticizer and flame retardant in rubber, paints and adhesives.

The use of these POPs in the context of the following priority areas and sectors is considered to identify alternative technologies and POP-s free materials:

- Exposure to POPs at homes and offices
- POPs release to the environment due to industrial / commercial scale production and use of POPs containing firefighting foams
- Intentional industrial uses of POPs in the manufacturing industry
- Unintentional release of POPs to the environment from industrial processes.

Currently, identification of alternatives to POPs-containing products can be difficult, due to *inter alia* a general lack of awareness about POPs, the large number of different chemicals, their wide range of uses, the difficulty in obtaining information on the composition of many products, and the fact that many alternatives are also POPs or have POPs-like characteristics.

Relevant data for each country were obtained from the latest National Implementation Plans (NIPs) prepared under the Stockholm Convention, and a range of secondary sources supported by a network of in-country technical experts.

In conducting the research, a number of challenges were encountered due to inconsistencies in reporting and methodologies used to quantify POPs production and consumption and a lack of available data. Notably, not all eight countries have published updated NIPs since the initial Conference of the

Parties (COP) in 2001. Since then, 19 new POPs have been added to the Convention, three of which (PFOS, HBCD and SCCP) are a specific focus of this report.

The research found that, as would be expected, there were fewer available alternatives and technologies for the POPs which were most recently added to the Convention. For example, for SCCPs, the majority of identified alternatives are also considered to have POPs-like characteristics and indeed are under consideration for addition to the Stockholm Convention. In terms of disposal of all four groups, whilst various remediation and disposal technologies have been developed, these are typically small scale and high-temperature incineration remains the preferred solution.

Inclusion of a technology or product on the EBRD's Green Technology Selector (GTS) platform requires that defined minimum performance criteria are met. For POPs technologies identifying criteria that are both clear in terms of relevance to POPs and also to the ENVITECC countries was a key aim. It is also essential to recognise that a number of technologies and products (currently) using POPs also need to meet additional criteria and specifications relating to safety and efficacy.

It is hoped that the identification of suitable alternative products and technologies and provision of clear, accessible information on POPs via the GTS platform will therefore contribute to the safe and responsible management of POPs-contaminated products in accordance with the Stockholm Convention and contribute to the wider body of knowledge on POPs and their alternatives.

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Annexes

List of Acronyms

ANGED	Agence Nationale de Gestion des Déchets (Tunisia)
ATH	Aluminium trihydroxide
BAT/BEP	Best Available Techniques/ Best Environmental Practice
BiH	Bosnia and Herzegovina
CMC	Critical micelle concentration
COP	Conference of the Parties
DDT	Dichlorodiphenyltrichloroethane
EA	Earth Active
EALs	Environmentally acceptable/adapted lubricants
EBRD	European Bank for Reconstruction and Development
ENVITECC	Financing Advanced Environmental Technologies in the Mediterranean Sea Region for Water Systems and Clean Coasts
EPS	Expanded polystyrene
EU	European Union
GEF	Global Environmental Facility
GET	Green Economy Transition
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
HBB	Hexabromobiphenyl
HBCD	Hexabromocyclododecane
IPEN	International Pollutants Elimination Network
LCCPs	Long-Chain Chlorinated Paraffins
LDAR	Leak Detection and Repair
MENA	Middle East and North Africa
MCCPs	Medium-Chain Chlorinated Paraffins
MPC	Minimum Performance Criteria
MWF	Metalworking fluids
NGO	Non-Governmental Organisation
NIP	National Implementation Plan
OECD	Organisation for Economic Co-operation and Development
PBDE	Polybrominated diphenyl ethers
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated dibenzodioxins
PCDF	Polychlorinated dibenzofurans
PFAS	Perfluoroalkyl and polyfluoroalkyl substances
PFCs	Perfluorinated chemicals
PFAS	Perfluoroalkyl and Polyfluoroalkyl Substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonic acid
PFOSF	Perfluorooctane sulfonyl fluoride
POPs	Persistent Organic Pollutants
ppm	Parts per million
PVC	Polyvinyl chloride
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SC	Stockholm Convention
SCCP	Short chain chlorinated paraffins
XPS	Extruded polystyrene
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organisation

1. Introduction

The European Bank for Reconstruction and Development (EBRD) has appointed Earth Active Ltd. (EA) to identify and assess off-the-shelf technologies for the responsible management of Persistent Organic Pollutants (POPs) in the Mediterranean region.

This assignment supports EBRD's Environmental Technology Transfer Programme (Financing Advanced Environmental Technologies in the Mediterranean Sea Region for Water Systems and Clean Coasts (ENVITECC)), funded by the Global Environment Facility under the Mediterranean Sea Programme: Enhancing Environmental Security (MedProgramme) (2020-2024)[1], which focuses on the depollution of the Mediterranean Sea, and the removal of POPs from the region. ENVITECC is aligned with the bank's Green Economy Transition (GET)[2] approach, to promote investments, which encourage the sustainable use of resources and protection of natural assets through the introduction of new technologies, equipment and practices into target markets.

POPs include a variety of organic chemical substances, shown to have a significant impact on the environment and human health. Many POPs can be transported by wind and water, meaning that those generated in one country may affect people, animals, and plants far from where they are used and released. They persist for long periods of time in the environment and can accumulate and pass from one species to the next through the food chain. The characteristics of POPs, notably their long environmental lifetime and the fact that they can have impacts far from where they were produced, means that countries need to work together for their elimination. The Stockholm Convention is a global treaty that aims to protect human health and the environment from the effects of persistent organic pollutants and focuses on eliminating or reducing releases of POPs[3].

2. Background

2.1 The EBRD's ENVITECC Programme

The EBRD's ENVITECC Programme is working to promote investment in wastewater treatment and recycling and reduce or eliminate POPs in eight target countries, namely Albania, Bosnia and Herzegovina, Egypt, Lebanon, Montenegro, Morocco, Tunisia, and Türkiye.

The ENVITECC programme forms part of a global effort to protect citizens and the environment from POPs, in accordance with a number of international conventions as summarised below.

[1] https://www.unep.org/unepmap/what-we-do/projects/MedProgramme
[2] https://www.ebrd.com/what-we-do/get.html
[3] http://chm.pops.int/TheConvention/Overview/tabid/3351/Default.aspx

Stockholm Convention on Persistent Organic Pollutants (2001)
Signed on 22nd May 2001 and coming into force on 17th May 2004, the Stockholm Convention, to eliminate or reduce the release of POPs into the environment, has been ratified by over 152 countries. The Stockholm Convention builds on the Aarhus Protocol, recognising a further six substances (Annex 1). The Stockholm Convention can be understood as having five key objectives (United Nations Industrial Development Organisation, 2022):

- Eliminate POPs
- Support the transition to safer alternatives
- Target additional POPs for action
- Clean-up old stockpiles and equipment containing POPs
- Work together for a POPs-free future

Since its creation, there have been nine meetings of the Conference of the Parties, during which time 19 new compounds have been added to the initial 12 listed under the Convention.

On 11th March 2022, Member States agreed to further restrict the presence of POPs in waste; these recent amendments largely cover limit values for dioxins and furans, which are present as impurities in some ashes.

All ENVITECC countries have ratified this convention and adopted it in their national legal frameworks

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989)
The Basel Convention was signed in 1989 and came into effect in 1992. Its overarching objective is to protect the health of humans and the environment from the adverse effects of hazardous waste, centring around the following principal aims:

- the reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes, wherever the place of disposal;
- the restriction of transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management; and
- a regulatory system applying to cases where transboundary movements are permissible.

All ENVITECC countries have ratified this convention and adopted it in their national legal frameworks.

The Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (1998)
The Rotterdam Convention came into force in 2004. Its purpose is to promote informed decision making and open information exchange over the trade, labelling and handling of hazardous chemicals and the following two primary objectives:

- to promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm;
- to contribute to the environmentally sound use of those hazardous chemicals, by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties.

All ENVITECC countries except Egypt have ratified this convention and adopted it in their national legal frameworks.

Aarhus Protocol on Persistent Organic Pollutants (1998)
The Protocol on Persistent Organic Pollutants (POPs) is an addition to the Geneva Convention on Long-Range Transboundary Air Pollution (1979) and was adopted in 1998, with the objective to 'control, reduce or eliminate discharge, emissions and losses' of POPs in Europe. As of 2013, the protocol has been ratified by 31 states and the European Union. 16 substances were originally included, and seven more have been recognised since the last amendments were made in 2009.

Montenegro is the only ENVITECC country that has ratified this Protocol.

2.2 Focus of this assignment

This assignment builds on a feasibility study carried out in 2017 for the EBRD during the Project Preparation Phase of ENVITECC, which identified activities and technologies that eliminate or significantly reduce the production and/or consumption of POPs in six countries in the Mediterranean Region (all ENVITECC countries with the exception of Lebanon and Türkiye).

The assignment focuses on PCBs, one of the original 12 listed POPs, and three new POPs, namely PFAS/PFOS, HBCD and SCCP (Annex 2), in the context of the following priority use areas and sectors:

(1) Exposure to POPs at homes and offices;
(2) POPs release to the environment due to industrial / commercial scale production and use of POPs containing fire-fighting foams;
(3) Intentional industrial uses of POPs in the manufacturing industry;
(4) Unintentional release of POPs to the environment from industrial processes.

The identification and implementation of innovative, resource efficient technologies and practices will improve the management of POPs-containing materials throughout their lifetime, to minimise risk of exposure to the natural environment.

Ultimately, it is intended that the technologies and POPs-free materials identified as part of this assignment will be made available in the EBRD's Green Technology Selector (GTS)[4]. GTS is a global shopping-style online platform launched by the EBRD in 2018 that connects vendors of the best green technologies with forward-thinking business and homeowners.

2.3 Overview of the approach to the assignment

The assignment comprises the following principal tasks:

2.3.1 Review of country-specific background information to identify baselines

Identification of production and consumption patterns for the four groups of POPs in each of the eight ENVITECC countries, considering the priority use areas and both intentional and unintentional production.

The findings of this task are presented in Section 0.

2.3.2 Identification of priority sectors for each country and each target POPs chemical

Taking each country in turn, the top sectors where implementation of commercially available POPs management measures (avoidance, treatment / remediation / safe disposal) would bring the maximum positive overall impact in terms of POPs elimination and reduction were identified.

The findings of this task are presented in Section 4.

[4] Green Technology Selector home page

2.3.3 Technology guide development

Off-the-shelf technologies and practices used in the avoidance, treatment, and disposal of the target POPs were identified. Where alternatives to POPs exist, further detail regarding environmental impacts, application constraints and financial costs are given.

The findings of this task are presented in Section 5.

2.3.4 Support to the development of the EBRD's Green Technology Selector

The Green Technology Sector promotes a broad range of green technologies, which are demonstrably best in class in that they exceed specified minimum performance criteria and standards e.g. in relation to energy efficiency, water use etc. POPs-free technologies are a completely new class of product for the GTS and minimum performance criteria were identified to enable onboarding of potential products and technologies.

2.4 Wider implications of this assignment

Currently, identification of alternatives to POPs-containing products can be difficult, due to *inter alia* a general lack of awareness about POPs, the large number of different chemicals and the complexity of their nomenclature, their wide range of uses, the difficulty in obtaining information on the composition of many products, and the fact that many alternatives are also POPs or have POPs-like characteristics.

Identification of suitable alternative technologies and provision of clear, accessible information on POPs will therefore contribute to the safe and responsible management of POPs-contaminated products in accordance with the Stockholm Convention.

Although this assignment focuses on the eight ENVITECC countries, the essentially global nature of chemicals manufacturing and thus production of POPs and POPs-free products and their use, means that the findings will contribute to the wider body of knowledge on POPs and their alternatives.

A note on nomenclature:

Per- and polyfluoroalkyl substances (PFASs) are chemicals that have partially or completely fluorinated carbon chains of varied lengths. These substances are used in almost all industry branches and many consumer products. The most-studied PFASs are perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and perfluorohexane sulfonic acid (PFHxS).

At the time of compilation of this Report, the latest overview of PFASs as reported at the Stockholm Convention website[5] are summarized below:

PFOS, its salts and PFOSF: In 2009, the Conference of the Parties (COP) listed PFOS, its salts and perfluorooctane sulfonyl fluoride (PFOSF) in Annex B to the Stockholm Convention (decision SC-4/17).

In 2019, following the evaluation of the continued need for PFOS, its salts and PFOSF, the COP amended Annex B to remove several of the specific exemptions and acceptable purposes for PFOS, its salts and PFOSF (decision SC-9/4).

PFOA, its salts and PFOA-related compounds: In 2019, the COP listed PFOA, its salts and PFOA-related compounds in Annex A to the Stockholm Convention (decision SC-9/12).

The updated indicative list of substances covered by the listing of PFOA, its salts and PFOA-related compounds is published by the Convention Secretariat (UNEP/POPS/POPRC.17/INF/14/Rev.1).

Part X of Annex A (paragraph 2 d) requires that the use of fire-fighting foam that contains or may contain PFOA, its salts and PFOA-related compounds to be restricted to sites where all releases can be contained by the end of 2022 if the party has the capacity to do so, or by 2025 at the latest.

PFHxS, its salts and PFHxS-related compounds: In 2022, the Conference of the Parties listed PFHxS, its salts and PFHxS-related compounds in Annex A to the Stockholm Convention (decision SC-10/13).

Initial indicative list of PFHxS, its salts and PFHxS-related compounds is published by the Convention Secretariat (UNEP/POPS/POPRC.15/INF/9).

Long-chain perfluorocarboxylic acids (LC-PFCAs), their salts and related compounds: The POPs Review Committee is currently reviewing LC-PFCAs, their salts and related compounds, proposed for listing in Annexes A, B and/or C to the Stockholm Convention.

It is important to note that, at the time of compilation of this Report, PFOS and PFOA are the only PFAS chemicals that are listed in the Stockholm Convention. The full name for PFOS is perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF)

This report therefore refers to PFOS rather than 'PFAS/PFOS' when considering the country-specific baselines, which are derived from the information produced under the Stockholm Convention.

PFAS are discussed in Section 6 given their ubiquity and significance.

[5] Industrial POPs: PFAS Overview. Stockholm Convention

3. Country-specific background information

3.1 Introduction

Relevant data for each country were obtained from the latest National Implementation Plans (NIPs) prepared under the Stockholm Convention (2001), as well as secondary sources such as Country Situation Reports published by the International Pollutants Elimination Network (IPEN)[6], and peer-reviewed scientific papers and reports published by organisations such as the Organisation for Economic Co-operation and Development (OECD). Where significant data gaps remained, Earth Active engaged a network of in-country technical experts to address these gaps as far as possible, for example by direct contact with relevant authorities in country.

Production and consumption patterns were identified, as defined by the General Guidance on POPs Inventory Development (Secretariat of the Stockholm Convention, 2020):

Production: of the POP or chemical preparations containing it (e.g. PFOS and formulations containing PFOS such as fire-fighting foams).

Net consumption of POP in [country]: [manufacture + import – export] of POP containing products or articles x POP content

Since most of the ENVITECC countries do not produce the target POPs themselves, but only import them (e.g. PFOS and HBCD, which are at this stage only produced in a limited number of countries), 'consumption' values therefore in most cases represent a country-wide inventory.

3.2 Methodological challenges

In conducting the research, some methodological challenges were encountered due to inconsistencies in reporting and a lack of available data. Not all ENVITECC countries have published updated NIPs since the initial Conference of the Parties (COP) in 2001. Since then, 19 new POPs have been added to the Convention, three of which (PFOS, HBCD and SCCP) are a specific focus of this report.

These inconsistencies have meant that where data are reported by one country, the equivalent data may not be available for other ENVITECC countries (because their NIP pre-dates the addition of some of the new POPs to the SC), so a variety of complementary sources have been utilised. A second issue is the accuracy with which countries quantify their POPs production and consumption patterns; given that the NIPs rely on self-reporting, the potential for under-reporting is relatively high, given that respondents may fear enforcement action based on the information they provide.

Conversely, quantification at a national level, which can be reliant on customs codes, may result in overestimation of consumption patterns dependent on the range of goods and materials covered by the code under consideration. Some NIPs therefore presented consumption figures as preliminary data, whilst more comprehensive surveys and inventory studies were included in the NIP action plans.

[6] IPEN is a global network of public interest NGOs working to support the elimination of hazardous chemicals through stronger management and legislation

3.3 Findings

3.3.1 Introduction

A summary of country-specific key findings for each of the four POPs is provided below; a comprehensive table is included in Table 1. Given the wide disparity in reporting methods, quality and timing, it is challenging to present figures that allow for direct comparison. However, key common threads that emerged include:

- All countries report progress in eliminating PCBs, although quantitative data of progress (eradicated equipment vs. remaining stockpiles) at national level are difficult to obtain.
- Unintentional releases of PCBs are frequently not quantified, though some NIP reports contain useful information on the most significant hotspots.
- Priority sector uses are typically consistent between countries, e.g. HBCD is mostly used in polystyrene, whilst PFOS' most significant use is in textiles.
- None of the eight target countries is included on the register of specific exemptions[7] or acceptable purposes[8] for any of the four groups of chemicals. Details on exemptions on certain uses (not country-specific) have been provided in Annex 2[9].

3.3.2 Albania

Albania published an updated NIP in 2017, addressing COP7 amendments, which covers all selected POPs with the exception of SCCPs. As a potential candidate to the European Union, the Albanian national legal framework is largely harmonised with EU legislation: the country has transposed EU regulation 850/2004 on POPs[10] since 2015. The Albanian inventory is derived from amounts imported under specific customs codes. This has led to inaccuracies as one code can cover several classes of good. Moreover, some methodological errors have been noted as well. For example, the PFOS amount related to fire foams was calculated on the basis that it contains 500 – 1500 mg/kg article; however, the UNEP guidance 2012 states the content is between 5000 and 15000, a factor 10x higher.

PCBs: PCBs have never been produced in Albania, however, oil containing PCBs was imported for use in transformers and PCBs continue to be used in Albania's energy sector, as oils in heat exchangers, transformers, capacitors. Albania's NIP does not report unintentional production of PCBs; however, they may be inadvertently produced during hazardous waste incineration processes. Scientific studies indicate pollution is prevalent; various water bodies in Albania have PCB levels of up to 36.57 µg/L.

PFOS: Although Albania does not produce PFOS or its salts, they are widely used in a number of sectors *inter alia* packaging, textiles including leather products, synthetic carpets, and hydraulic fluids. The average amount of PFOS exposed is 7,208 kg/year, with the main sources of emissions into the environment being kitchen paper, plasticised cartons, packages and letters, leather products and hydraulic fluids. Synthetic carpets, textiles and tapestry and leather use also contribute to PFOS usage.

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[7] Specific Exemptions. Stockholm Convention
[8] Acceptable purposes. Stockholm Convention
[9] Türkiye previous had an exemption for production and use of HBCD, which expired on 26.11.2019, and a registration of an acceptable purpose for PFOS with respect to photo-imaging, which expired on 12.05.2015
[10] Regulation (EC) No 850/2004 of the European Parliament and of the Council of 29 April 2004 on persistent organic pollutants and amending Directive 79/117/EEC.

HBCD: HBCDs are not produced in Albania, however they are used widely in the textiles sectors (76,940 kg) and construction sectors (11,990 kg). These are approximate inventory figures of material in country, the NIP does not provide details of the methodology used to arrive at these estimates (e.g. over which time span). Our in-country expert confirmed that no further detail was available. According to the 2017 NIP, the main application of HBCD is polystyrene foam, which contain 0.7 – 3% HBCD. Textile coverings also contain HBCD at concentrations of 2.2 – 4.3%.

SCCPs: Albania does not produce SCCPs, though they are still imported. Albania proposed control measures on 29 April 2015 to prohibit the production, placing on the market, and use of SCCPs, however as of 2016, SCCPs remain in use in the country. The amount imported cannot be fully quantified as the related custom code covers several goods, and custom documentation is not complete. It is understood that the Ministry of Environment is currently reviewing the use of SCCPs and the relevant legal framework in order to eliminate them in accordance with EU regulations.

3.3.3 Bosnia and Herzegovina

Bosnia and Herzegovina's (BiH) latest NIP was published in 2015, addressing COP 4 amendments, and therefore does not contain any information on HBCD or SCCP. It particularly highlights the challenge of limited statistical data (e.g. on waste management, site remediation and the import of POPs), due to limited laws and monitoring regulations, as well as lacking knowledge of responsible personnel completing the survey questionnaires.

At the time of writing, the Inventory Report of Persistent Organic Pollutants (POPs)[11] project implementation by UNDP is under way, with the goal of performing sampling at the sites and mapping locations contaminated by POPs in BiH. The site sampling phase is now complete, but the results have yet to be published. Sites include major industrial and agricultural sites, airports, landfills, etc., and depending on the site, sampling has been undertaken for PCBs, PCCD/F, HBB, PBDE, pesticides and PFOS.

PCBs: PCBs have never been produced in BiH and were usually imported from Serbia or Slovenia, however PCB-containing equipment is still in use, including transformers, capacitors and switches. With regards to unintentional production, the NIP identifies three hotpots that are contaminated with PCBs (where leakage and hence unintentional production occurs). The sites comprise an electricity distribution site (Zenica in the municipality of Jelah), as well as two coalmines in the municipalities of Durdevik and Breza. For the period from 1992 to the present day, there is no comprehensive information on import of equipment containing PCBs. This is because customs of Bosnia and Herzegovina have no specific tariff code for transformers / capacitors containing PCBs. Consumption is negative as waste containing PCBs is being exported; a total of nearly 3,000 tonnes of PCBs was exported between 2003 to 2013, and another 111 tonnes in 2015 as part of the Med Partnership Project.

PFOS: BiH has never manufactured PFOS or its salts, but does import and use products that contain them. Based on national statistics (import and export data as cited in the most recent NIP), the total PFOS consumption in 2012 was between 47.16 and 284.20 tonnes. The vast majority of this figure is associated with coating and coating additives (25.6 – 257 tonnes),

[11] UNDP (ongoing project). Environmentally Sound Management of Persistent Organic Pollutants (POPs) in Industrial and Hazardous Waste Sectors

followed by cleaning agents (waxes and polishes) and synthetic carpets. It was also used as a mist suppressor in the electroplating industry until 2015.

HBCD: Although HBCD was not covered in the NIP, according to the inventory developed under *"Environmentally Sound Management of Persistent Organic Pollutants (POPs) In Industrial and Hazardous Waste Sectors in BiH"*, HBCD was most likely never produced in Bosnia and Herzegovina. The total estimated quantity (based on import and export data as cited in the most recent NIP) of HBCD present in buildings is 290-590 tonnes. No new EPS/XPS products containing HBCD are produced.

SCCPs: There are no data available on SCCPs in BiH. Currently there is consent to import under specific conditions (e.g. preparations containing SCCPs in concentrations lower than 1% by weight)[12].

3.3.4 Egypt

Egypt published an initial NIP in 2005, but has not provided any updates since. Therefore, there are no official data on PFOS, HBCD and SCCPs. However, through the Egyptian Environmental Affairs Agency (EEAA) it has implemented several projects related to the elimination of POPs (mostly focused on PCBs) in partnership with international partners such as JICA, UNEP, GEF, UNIDO, FAO, WHO and the World Bank.

The updated NIP is planned to be issued in 2022 and will include the new POPs, although at the time of writing (November 2022), it has yet to be published. It will likely be based on theoretical analysis rather than actual field inventories; a preliminary inventory was shared by the national expert, covering PBDEs, HBCD, PFOS and SCCP.

PCBs: Although not explicitly stated in the NIP and whilst conclusive data on global producers of PCBs are missing, it is unlikely Egypt had a significant history in PCB production. PCBs are still contained within closed appliances in the power sector (those manufactured between 1950 – 1978); a 2005 inventory identified 3,666 condensers containing PCBs and 26 transformers which contain a total of 20,490 kg of PCB contaminated oil. The use of PCBs and equipment using PCBs is to be completely stopped by 2025. Whilst there is no recent NIP to address progress on this target, Egypt undertook an initiative (MedPartnership Project, led by UNEP/MAP and funded by the GEF) to dispose of 200 tonnes of PCBs in 2016.

PFOS: There are currently limited data on PFOS in Egypt because the country has not yet published an updated NIP. A 2016 paper[13] identifies food contact paper and dust as being contaminated with PFOS (0.29 ng/g in food contact paper and 4.09 ng/g in dust), although notes that levels in household dust are typically lower in Egypt than many other countries due to the fact that imported wall to wall carpeting is not typically used in Egyptian homes. Instead, locally manufactured carpets are typically used, which are not generally treated with PFOS.

HBCD: There are currently no data available on HBCD in Egypt, though it will likely be included in the new NIP. The preliminary inventory indicated it is less likely to have been used in the textiles sector after 2015. Information obtained by our national expert indicates that consumption in the transport textiles sector is estimated between 243 and 1,655 tonnes per year.

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[12] Stockholm Convention, [u.d.]. Import Responses. Short-chain chlorinated paraffins.
[13] Shoeib T, Hassan Y, Rauert C, Harner T. Poly- and perfluoroalkyl substances (PFASs) in indoor dust and food packaging materials in Egypt: Trends in developed and developing countries. Chemosphere. 2016.

SCCPs: SCCPs are not produced in Egypt, however they are used in the processing of polyvinylchloride (PVC) and in some textiles and lubricants. Detailed inventories of imported SCCPs are lacking, though data may be included in the new NIP.

3.3.5 Lebanon

Lebanon's most recent NIP was published in 2017, addressing COP7 amendments and therefore does not contain information on SCCPs. The NIP highlights a number of challenges that were experienced in the production and implementation of the previous NIP, which included a lack of sufficient resources, both financial and technical, and the need to enhance awareness and communication amongst stakeholders. Specific measures to address these challenges include strengthening the legal and institutional framework for POPs chemicals management in Lebanon and the establishment of a National Implementation Unit (NIU).

PCBs: PCBs were never produced in Lebanon, but PCBs were used widely prior to the 1990s; PCB-free oil has been used in transformers now for many years. There is no quantification of unintended production (leakage) of PCBs in Lebanon, however 7 hotspots are listed: 2 power plants, 4 substations and an EDL (Electricité du Liban) repair shop (all damaged by airstrikes). The latter is the most critical; 1,600 transformers are stored on site and the remediation and safe disposal of the damaged equipment, including potentially PCB contaminated oil, is clearly a priority.

PFOS: PFOS and its salts are not produced in Lebanon, and there is no national inventory of PFOS. Lebanon's IPEN report highlighted fire-fighting foams as a likely major source, and POPs-containing AFFF foams are imported into Lebanon for use at gas stations.

HBCD: HBCD is not produced in Lebanon. Data on HBCD usage are incomplete as a high proportion of contacted firms did not respond, although the NIP reports total imports of 3,300 tonnes EPS construction insulation foams over the period 2004 – 2014. Likely usage includes construction, insulation foams, textile, and paints.

SCCP: There are no data available on SCCPs in Lebanon.

3.3.6 Montenegro

Montenegro's most recent NIP was published in 2019, addressing COP 5 amendments. As a potential candidate to the European Union, the Montenegrin national legal framework is largely harmonised with EU legislation: on December 7, 2022, existing legislation was revised to further align with EU POPs regulations[14].

PCBs: PCBs have never been produced in Montenegro, however PCB-containing oil has been imported for use in transformers and capacitors. The most recent NIP includes planned measures which aim to fully identify and eliminate PCB-containing fluids in devices by 2025. Unintentional release of PCBs in Montenegro is mainly related to uncontrolled burning processes at open dumps. Release of PCBs reduced from 6.79 g/year in 2006 to 2.57 g/year in 2016. Leakage was not considered as potential source of unintentional release of PCBs.

[14] Official Gazette of Montenegro Number 134/2022, 1865

PFOS: PFOS and its salts are not produced in Montenegro, and no PFOS-containing fire-fighting foams have been used in the last ten years, according to the NIP. There are no industries in Montenegro that use PFOS.

HBCD: There are no registered producers of HBCD. The estimated total consumption of HBCD in Montenegro for the period 2006-2016 is 34,359 tonnes. The total estimated amount of HBCD in Montenegro (products that potentially contain it and from the construction waste), as of 2016, is 3,661 tonnes.

SCCPs: Import and usage of SCCP is prohibited[15] since 2017.

3.3.7 Morocco

Morocco was one of the earliest signatories of the Stockholm Convention in 2001, with ratification in 2004. However, comprehensive legislation regarding POPs is not in place yet, but highlighted as priority actions in the latest NIP of 2019, addressing COP8 amendments (e.g. reporting and registration of PCB contaminated transformers, to reduce non-intentional production of POPs, as well as controlling POP concentrations in the environment).

PCBs: All transformers produced in Morocco are now PCB-free, however a total of 103 transformers with contamination above 5,000ppm have been identified, of which are 89 still in service. The total PCB content of this equipment is calculated to be 43,785 kg, whilst some 1,530 tonnes of PCB-containing equipment has been eliminated. Morocco's NIP does not include an assessment of unintentional release of PCBs.

PFOS: PFOS has never been produced in Morocco, however consumption is estimated at between 1,324.8 kg per year and 13,092.0 kg per year, largely attributed to paper, packaging, carpet, and leather coatings.

HBCD: HBCD has never been produced in Morocco, but HBCD is used in the construction and textile sectors, with total usage estimated at between 126,911 and 458,791 kg for 2013.

SCCPs: There are no data available on SCCPs in Morocco.

3.3.8 Tunisia

Tunisia was one of the earliest signatories of the Stockholm Convention in 2001, with ratification in 2004. Several decrees specifically covering PCBs and other POPs are being drafted (although are not yet in force). Tunisia published its most recent NIP in 2018, addressing COP 4 amendments which therefore includes HBCD and PFOS, albeit as preliminary data (the NIP does call for developing detailed inventories for PFOS, HBCD (and PBDE)). SCCP was not included, nor was it part of the inventory plan.

PCBs: Tunisia has never produced PCBs. The NIP identifies some 1,212 tonnes of equipment and contaminated soil that have already been processed and a further 1,214 tonnes of equipment containing PCBs has been identified by the Agence Nationale de Gestion des Déchets (ANGED) to be withdrawn to address the SC's 2025 target.

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[15] SCCP are not included in the list of registered chemicals in Montenegro ("Official Gazette of Montenegro" no. 051/17 as of 03/08/2017)

PFOS: Tunisia does not produce PFOS but did import PFOS-containing products (including fire-fighting foams) from abroad until 2011. Estimated quantities of PFOS remaining in waste are between 18.4 and 160.87 tonnes.

HBCD: HBCD is not produced in Tunisia and is not imported as a pure substance but is imported as a component of mixtures and raw materials. The estimated quantities of HBCD sold annually on the Tunisian market is around 85 tonnes (in the form of polystyrene).

SCCPs: Data are not available on SCCPs in Tunisia.

3.3.9 Türkiye

Türkiye ratified the Stockholm Convention in 2009, and published its most recent NIP in 2022, to address the COP 9 amendments. In 2018, Türkiye published Gazette No. 305951 on the Regulation of Persistent Organic Pollutants, which has been drafted to align with the EU POPs Regulations (EC) No. 850/2004.

PCBs: PCBs have never been produced in Türkiye. A total of 1,080 tonnes of pure PCB-containing materials were identified in a 2013 inventory, of which 634 tonnes have already been eliminated. The 2022 NIP still cites the 2013 inventory as being the latest; there are no more recent figures for PCB elimination carried out since 2016. The NIP does cite some studies on ambient PCB levels in the air, generally demonstrating PCB levels are low in the atmosphere. Some hotspots with notable concentrations include Bursa (a city with 18 industrial zones), Izmir and Kocaeli.

PFOS: PFOS is not produced in Türkiye. Net consumption of PFOS (difference between the import and export amounts) quantities significantly decreased between 2017 – 2019, by 985 kg. The latest (2019) consumption figure is 40 kg/annum. Consumption of PFOS-related substances[16] was negative in 2019: -11.83 tonnes. There are no data available on PFOS wastes in Türkiye.

HBCD: Türkiye's NIP does not give production figures for HBCD but assumes that production does not take place. However, there are 4 expanded and 7 extruded polystyrene producers in the building and construction sector in Türkiye and the industry is the largest in the Middle East and Central Asia region and the third largest in Europe. The annual HBCD consumption was therefore high (up to 1,214,167kg/annum), until its use was banned in 2020 through the By-law on Persistent Organic Pollutants. A stockpile of 23 tonnes was disposed of with the support of GEF.

SCCPs: An SCCP inventory for Türkiye identified SCCP to be present in the country, however no specific data on this chemical have been released, as legislation is new. Based on TURKSTAT data, the NIP estimates a 14.7 tonnes net consumption figure for 2019 (materials containing SCCP). However, this is likely an over-estimate and does not indicate the actual SCCP content. Import is allowed if concentration in substances lower than 1% by weight / or 0.15% in articles containing SCCPs. Import and export amounts have been included in NIP (around 16 tonnes residual amount per year), though it is indicated this is likely an overestimate and more detailed inventory is required

[16] Defined as a substance containing one or more PFOS groups that can, or are assumed to be, degraded to PFOS in the environment. Restricted through the listing of PFOSF under the Stockholm Convention

Table 1: Country-specific Background Information

POPs Baseline		PCBs	PFOS[17]	HBCD	SCCP
Albania	Production[18]	None / no data on unintended production. NIP (2017): PCBs were never produced in Albania. Transformer oil was always imported from other (European and Asian) countries. The NIP does not report on unintended production (e.g. hotspots where leakage may occur) of PCBs. Various studies on PCBs in Albania[19] Scientific studies indicate pollution is prevalent, as various water bodies (e.g. Vjosa, Aoos and Devola rivers) have PCB concentrations of up to 36.57 µg/L. The origin of PCBs in river ecosystems is mainly because of atmospheric deposition.	None. NIP (2017): Perfluorooctane sulfonic acid (PFOS), its salts, Perfluorooctanesulfonyl fluoride (PFOSF) are not produced in Albania.	None. NIP (2017): Hexabromocyclododecane (HBCD) is not produced in Albania, but is contained in goods and equipment which are currently used.	None. POPs Review Committee Twelfth meeting 01/06/2016[20]: Albania proposed control measures on 29 April 2015 to prohibit the production, placing on the market and use of SCCPs. The National Environmental Agency will maintain a database and report every four years on the progress made to eliminate SCCPs SC/ Request for information specified in Annex E for SCCPs Based on the information from National Environment Agency, there are no activities licensed to produce this substance.
	Usage	8,680 tonnes of PCB oil in transformers present NIP (2017): Comprehensive data are lacking. A full study remains to be undertaken (part of Albania's 2017 Action Plan) to analyse the presence of PCBs, not only in transformer oils, but also in soil, sediments, water and organisms. The total number of transformers used in the energy sector is about 12,789, while the total quantity of transformer oil is about 8,679,542 litres. During the first inventory on PCBs carried out in 2005, it emerged that 5.3% of the inspected	Consumption between 1.86 – 12.55 tonnes/year (note: likely much higher as NIP calculation is identified to contain errors) NIP (2017): PFOS are contained in goods and equipment which are currently being used in Albania. According to the NIP, the estimated annual PFOS (and its related substances) consumption (in kg/year) varies from 1863.75 kg/year to 12,552.5kg/year (*), or the average amount of PFOS exposed is 7,208 kg/year.	2017 NIP inventory: 88.93 tonnes (construction + textile sector) NIP (2017): People are widely exposed to HBCD; with the majority of the pollution coming from textiles used in household furniture. Extended and extrusion polymers have been the main users of HBCDs at national market. Total 2017 NIP inventory:	No specific data / import still allowed, though Ministry in process of reviewing exemptions. POPs Review Committee Twelfth meeting 01/06/2016 SCCPs are still imported by Albania. Albania consents to import subject to specified conditions[21]: SCCP, are included in part B, of Annex I, with some specific exemptions, which allows the placing on the market and

[17] The Guidance for Developing a National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants (January 2017) requires reporting on PFOS, its salts and PFOSF and PFOS related chemicals. Assessment of PFAS is not included in the guidance, hence reporting is limited. The data provided in this column therefore refers to PFOS unless explicitly stated otherwise.
[18] The Stockholm Convention lists the 5 POPs as applicable to Article 5 (Measure to reduce or eliminate releases from unintentional POPs), which includes PCBs. Unintentional production of PCB, according to the Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs under Article 5 of the Stockholm Convention, is mainly described as PCB leakage. Details on PCB leakage hotspots have therefore been included as unintended POP production. The other POPs are not included in Article 5.
[19] "A preliminary study of persistent organic pollutants in waters of Vjosa river, Albania", Elda Marku, Aurel Nuro, 17th International conference on chemistry and the environment 16-20 June 2019, Thessaloniki, Greece" and "Impact of floods on concentration of organic pollutants in Aoös River, Albania", 2020, Armela Tafa, International Journal on Environmentalist Analytical Chemistry"
[20] Stockholm Convention, 2016. Draft risk management evaluation: short-chain chlorinated paraffins UNEP/POPS/POPRC.12/11/Add.3
[21] Stockholm Convention, [u.d.]. Import Responses. Short-chain chlorinated paraffins.

		amount of oil was contaminated with PCBs, mainly found in small transformers. About 47% of the total number of transformers are manufactured before 1990 (about 6,000 units), and may therefore contain PCBs.	The main source of pollution is the use of kitchen paper, packaging and various cardboards, followed by synthetic carpets, textiles and tapestry, and leather use. Goods with lower potential include adhesives and varnish, hydraulic fluids (oils) used in aviation and fire-fighting foams. Fire foam is only a small contributor, with an estimated consumption of 5-10kg of PFOS per year. (*) It is noted that the NIP had significant methodological errors. For example, the PFOS amount related to Fire Foams was calculated on the basis that it contains 500-1500mg/kg article; however, the UNEP guidance 2012 states the content is between 5000 and 15000, a factor 10x higher.	Data below are annual but specific year not reported in NIP. Construction sector: 11,990 kg (mainly in ceiling insulation, as well as internal and external wall insulation). Textile sector: 76,940 kg (mainly in household furniture, vehicle upholstery and mattresses).	use of substances or mixtures which have SCCP in their content in a concentration less than 1% of weight. <u>SC/ Request for information specified in Annex E for SCCPs</u> Based on the information from General Directory of Customs, custom code nr. 3824 9097 there are several imports in Republic of Albania. But this custom code includes several goods, which only partly can correspond to the SCCPs CAS no 85535-84-8. Also keeping in mind that there is not a complete documentation of customs practices, a concrete, right information cannot be given. Based on the information from customs, a good part of these imports are made from subjects operating in the field of hydrocarbons. Currently the Ministry reviews the exemptions in order to completely eliminate SCCPs from being used. In addition, the legal basis that regulates this matter is being reviewed, in accordance with the EU's regulations as well.

POPs Baseline		PCBs	PFOS	HBCD	SCCP
Bosnia and Herzegovina	Production	None / no quantification of unintended production (leakage) of PCBs. NIP (2015): PCB mixtures were never manufactured in Bosnia and Herzegovina, nor was there any production of equipment containing PCBs. The NIP identifies three hotpots that are contaminated with PCBs (where leakage and hence unintentional production occurs). The sites comprise an electricity distribution site (Zenica in the municipality of Jelah), as well as two coalmines in the municipalities of Durdevik and Breza. Qualitative analysis of samples from Zenica and Breza found presence of PCBs and there were reports of an explosion at Durdevik, which is assumed to have resulted in leakage. The PCB Inventory group was unable to examine the quantity of leaked fluids at these locations and so combined with the qualitative analysis undertaken, there is no quantification of the leakage available.	None. NIP (2015): BiH has never manufactured PFOS, but only imported and used products that may contain PFOS. Inventory developed under *"Environmentally Sound Management of Persistent Organic Pollutants (POPs) in Industrial and Hazardous Waste Sectors in BiH"*[22] PFOS was most likely never produced in Bosnia and Herzegovina. No new consumer products containing PFOS are produced.	No specific data NIP (2015): No information Inventory developed under *"Environmentally Sound Management of Persistent Organic Pollutants (POPs) in Industrial and Hazardous Waste Sectors in BiH"* HBCD was most likely never produced in Bosnia and Herzegovina.	No specific data NIP (2015): No information
	Usage	Negative consumption, PCB containing waste being exported (comprehensive import figures not available) 106,167 tonnes of waste containing PCBs NIP (2015): A preliminary inventory of PCBs was carried out in 2013. A challenge that was encountered was that during the military siege a large number of power generation equipment was damaged and identification plates were damaged or have gone missing. Furthermore, from 1992 to present it is not possible to obtain information on the import of equipment containing PCB due to lacking legislation and customs regulations. PCBs in BiH are present in closed applications (transformers, capacitors and switches) and barrels used for storing used oil, and equipment containing PCBs is still being used. Among companies that were willing to cooperate with the studies, 106,167 tonnes of waste was identified (72% capacitors, 25% transformers and 3% in oil barrels). Given the methodological challenges, the real number may be higher.	Consumption between 47.16 and 284.20 tonnes (in 2012). NIP (2015): Based on national statistics (import and export data), the total PFOS consumption in 2012 was between 47,159kg and 284,200 kg. The vast majority of this figure is associated with coating and coating additives (25,696 – 256,964 kg), followed by cleaning agents (waxes and polishes) and synthetic carpets. Due to inconsistencies in product codes (statistical data on production of items do not have the same production codes as customs tariffs for imported and exported products), the PBDEs/PFOS Inventory Group considers these calculations to be an estimate. A preliminary inventory of PFOS was carried out in 2013. Based on inventory analysis, the total quantities of fire-fighting foams in BiH in stocks amount to 8,455 litres, and the range of PFOS quantities in BiH is 4.22 to 12.67 litres.	290-590 tonnes present in buildings. NIP (2015): No information Inventory developed under *"Environmentally Sound Management of Persistent Organic Pollutants (POPs) In Industrial And Hazardous Waste Sectors In BiH"* No new EPS/XPS products containing HBCD are produced. Landfills represent one ultimate destination of HBCD containing materials. No stocks of HBCD were identified at the EPS/XPS industries. The total quantity of HBCD present in buildings is 290-590 tons, based on import and export data.	No specific data / Consent to import under specific conditions NIP (2015): No information Inventory developed under *"Environmentally Sound Management of Persistent Organic Pollutants (POPs) In Industrial And Hazardous Waste Sectors In BiH"* Not included Rotterdam Convention website[12]: Consent to import under specific conditions: 1. The production, placing on the market and use of substances or preparations containing SCCPs in concentrations lower than 1 % by weight shall be allowed.

[22] UNDP (ongoing project). Environmentally Sound Management of Persistent Organic Pollutants (POPs) in Industrial and Hazardous Waste Sectors

		In the period from 2008 to 2013, a total amount of approximately 350kg of PCBs were imported. A total of 2,814,155 kg of waste containing PCB was exported for processing between 2003 and 2013. <u>Inventory developed under *"Environmentally Sound Management of Persistent Organic Pollutants (POPs) In Industrial And Hazardous Waste Sectors In BiH"*</u> Based on information received from the Customs Sector of the Indirect Taxation Authority of Bosnia and Herzegovina,[23] in the period 2006-2020 a total of 457 kg of waste oils containing polychlorinated biphenyls (PCBs), polychlorinated terphenyls (PCTs) or polybrominated biphenyls (PBBs) was imported in Bosnia and Herzegovina and 363,776 kg was exported. With regards to mixtures containing halogenated derivatives of methane, ethane or propane containing polychlorinated biphenyls (PCBs), polychlorinated terphenyls (PCTs) or polybrominated biphenyls (PBBs), a total of 150 kg was imported in Bosnia and Herzegovina in the period 2006-2020, and no export was recorded. As part of the Med Partnership Project 'Environmentally sound management of equipment, stocks and wastes containing or contaminated by PCBs in national electricity companies of Mediterranean countries', in November 2015 a total of 111,018 kg of PCB containing or contaminated equipment and waste was exported from Bosnia and Herzegovina, of which 85,693 kg total solid and 20,345 kg total liquid. Given that according to the Indirect Taxation Authority of Bosnia and Herzegovina a total of 8,580 kg of waste oils containing PCBs was exported in 2015, it is assumed that only exported drums with liquid PCB were recorded within the Customs Sector of the Indirect Taxation Authority of Bosnia and Herzegovina. However, the Consultant could not obtain the information from Customs about the exported equipment containing PCBs given the lack of specific tariff code for transformers/ capacitors containing PCBs.	<u>Inventory developed under *"Environmentally Sound Management of Persistent Organic Pollutants (POPs) In Industrial And Hazardous Waste Sectors In BiH"*</u> PFOS was used as a mist suppressor in the electroplating industry until 2015. The wastewater from the galvanisation baths is treated in a wastewater plant and/or hazardous waste companies. Due to the past unsound management of wastewater in these industries, potentially PFOS has been released to the environment. Over the period from 2004 to 2016, a total of 10,994 kg PFOS and related chemicals were imported.		2. The production, placing on the market, and use of the following applications shall be allowed provided that report on the progress made to eliminate SCCPs is submitted to the Ministry of Health and Social Welfare no later than 2015 and every four years thereafter: (a) fire retardants in rubber used in conveyor belts in the mining industry; (b) fire retardants in dam sealants. 3. Placing on the market and use of articles containing SCCPs as a constituent of such articles shall be allowed until 31 December 2013 if they are produced before or on 3 August 2013.

[23] Information provided to Dekonta as part of this study

POPs Baseline		PCBs	PFOS	HBCD	SCCP
Egypt	Production	None / no quantification of unintended production (leakage) of PCBs. NIP (2005): Production is banned in Egypt. No quantification of unintended production of PCBs. IPEN Country Situation Report (2005)[24] PCBs production has stopped in compliance with international agreements in the first half of the 1980s. Under the governments' supervision on the industrial facilities, no PCBs are being manufactured in Egypt. IPEN Country Situation Report (2005) Reports incidence of PCB contamination at the Shoubra El Khema cable factory and refers to a study undertaken in the vicinity of Helwan (steel mill power station and coke factory), which demonstrated high PCB contamination, implying substantial leakage has occurred.	Limited specific data NIP (2005): No information IPEN Egypt PFAS situation report (2019)[24] Currently there is no information available on production of PFAS substances in Egypt.	No specific data NIP (2005): No information	None NIP (2005): No information The Preliminary inventory shared by the national focal point states that according to the data received from the Chemical Industry Chamber- Ministry of Industry, SCCPs officially are not produced in and/or exported to Egypt.
	Usage	20.5 tonnes of PCB oil in transformers that remain in service NIP (2005): Usage is banned in Egypt. At the time of the first NIP publication, there was no existing inventory data on PCBs. However, a preliminary inventory concluded that there were 3,666 condensers and 26 transformers manufactured between 1955 and 1977. PCBs were used widely in transformers, capacitors, voltage regulators, hydraulic systems, small capacitors in fluorescent lighting ballasts, and heat transfer systems. Quantities for the latter category have not been reported, presumably because they are too small. The transformers contain 20,490 kg of oil that contains PCBs. IPEN Report on PCBs (2019)[24] Highlights difficulty of obtaining data as the users of PCBs are reluctant to share information out of fear they may be subject to fines or other liabilities. Notwithstanding these difficulties, a joint effort of the Ministry of Environment, Ministry of Electricity and the World Bank led to the sampling of 18,750	Limited specific data NIP (2005): No information; the Stockholm Convention amendment listing PFOS came into force for Egypt in 2010, an updated NIP has not been published since. IPEN Egypt PFAS situation report (2019)[24] Currently there is no information available on production, import, use or management of PFAS substances in Egypt, nor on PFAS impacts or contaminated sites. PFAS are unregulated in Egypt. Studies cited in this report show that products such as food contact paper were contaminated with PFAS substances, and PFOS/PFAS was also encountered in dust analysed in 17 homes, 5 workplaces and 9 cars in Cairo. Currently there is no information available on production, import, use or management of PFAS substances in Egypt.	243 and 1,655 tonnes per year in transport textiles sector (as of 2016). NIP (2005): No information The Preliminary inventory shared by the national expert has not yet identified any usage of HBCD as additive material in the manufacturing of polystyrene. In the textile sector, the preliminary inventory states that HBCD use can be assumed until about 2013/14; after 2015 it is less likely to be used. There are no data on using HBCD in the transport textiles sector, though using the UNEP guidelines the consumption is estimated between 243 and 1,655 tonnes per year as of 2016.	None NIP (2005): No information The Preliminary inventory shared by the national expert states that some imported articles and goods may contain SCCP. No actual inventory has been undertaken to date, nor is it likely to be included in the new NIP.

[24] IPEN 2005. Country Situation Report for Egypt.

		suspected transformers, out of which 11,123 were analysed. 711 of these turned out to be contaminated, with a total of 948 tons of contaminated oil. Five projects were implemented between 2006 and 2016, which included the disposal of several stockpiles of contaminated oils. UNEP 2016 Press release[25] As part of the MedPartnership Project, led by UNEP/MAP and funded by the Global Environment Facility (GEF), Egypt undertook to gather PCB-contaminated equipment in Cairo and Alexandria to ship them to Spain for elimination, with the goal of disposing 200 tonnes of PCBs. Historical production unclear but unlikely to be significant. Over the years a number of different initiatives have been undertaken in Egypt to create inventories of PCBs. These include: • Regional Environmental Management Improvement Project (JICA 2006-2008) • Sustainable management of POPs project (GEF-WB phase 1 2010; phase 2 2015) • Integrated PCBs Management Project (MEDPOL/UNEP 2011-2016) The main holder of PCB-contaminated equipment is the Ministry of Electricity and Renewal Energy "Mere". Petrotrade Company (and its subcontractors) is the only authorised company to collect oils and to give to Alexandria Petroleum Company and AMOC Company. These companies are holding potentially contaminated oil and recycle it thus leading to dilution and dispersion.	The Preliminary inventory shared by the national focal point includes an analysis of PFOS in various sectors: • Paper and packaging: PFOA detected in 79% of samples with median concentration of 2.40ng/g. PFOS detected in 58% of samples with median concentration of 0.29ng/g. Total amounts: 66.67g PFOA and 8.06 PFOS in paper products used for food packaging. • Textiles: likely PFOS-free, alternatives used such as C6-Fluorocarbon resin with hyper branched polymers in a hydrocarbon matrix, cationic).		

[25]UNEP, 2016. Egypt disposes of its PCB-contaminated equipment.

<table>
<tr><th colspan="2">POPs Baseline</th><th>PCBs</th><th>PFOS</th><th>HBCD</th><th>SCCP</th></tr>
<tr><td rowspan="2">Lebanon</td><td>Production</td><td>None / no quantification of unintended production (leakage) of PCBs

<u>NIP (2017)</u>
Production is banned in Lebanon. The NIP does not include an estimate of leakage / unintended production of PCBs.

<u>IPEN Country situation report (2006):</u> [26]
The country hosts two companies that manufacture and/or supply distribution transformers: Matelec (Lebanese company) and Elprom (Bulgarian company). Both companies have been using PCB-free oil for many years.

<u>World Bank Blog (2021)</u>[27]
Prior to the mid-1990s, PCBs were widely used in power transformers and capacitors in power stations, substations and distribution transformers.</td><td>None.

<u>NIP (2017)</u>
PFOS and related substances are currently not produced in Lebanon.</td><td>None.

<u>NIP (2017)</u>
HBCD is currently not produced in Lebanon as per information retrieved during the 2016 assessment covering the period of 2004-2014</td><td>No specific data

<u>NIP (2017)</u>
No information</td></tr>
<tr><td>Usage</td><td>None / negative (due to export for disposal).

<u>NIP (2017)</u>
Lebanon's substations use and have been using PCB-free oil for many years. PCB oil or PCB contaminated oil may nevertheless be present in substations subject to more extensive testing.

<u>World Bank Blog (2021)</u>
With WB support and GEF funding, Lebanon undertook a project (May 2015 – Mar 2021) to eliminate PCB contaminated power transformers in an environmentally sound manner. 23,044 assets were surveyed, identifying 1,380 transformers contaminated with PCBs.
In total 389 tonnes of hazardous waste was disposed of (shipped to a licenced facility in France in accordance with the Basel Convention)
A draft legal decree that ensures the effective management of PCBs was also developed, aligning regulations with the priorities set by the Stockholm Convention. 1,435 tonnes of PCB contaminated transformers remain to be eliminated.</td><td>Limited specific data

<u>NIP (2017)</u>
An estimated 56 to 167 kg of PFOS were released between 2004 and 2014 from fire-fighting foams.

A total of 6,240 litres of PFOS containing fire-fighting foam were used in fire incidents in Great Beirut between 2004 and 2014, over a total surface area of 5,960m^2.

<u>Lebanon PFAS Situation Report (2019)</u>[28]
Currently no national inventory of PFAS substances.
No specific PFAS regulations have been implemented yet.
Fire-fighting foams are a likely major source of PFAS; PFAS-containing AFFF foams are imported into Lebanon, primarily for use at gas stations.</td><td>Limited specific data

<u>NIP (2017)</u>
(Data incomplete as high proportion of contacted firms did not respond)

EPS construction insulation Foams: total import of 3,300 tonnes of HBCD between 2004 and 2014.

Textile and Paints: no specific figures.</td><td>No specific data

<u>NIP (2017)</u>
No information</td></tr>
</table>

[26] IPEN, 2006. Lebanon Country Situation Report.
[27] Wang, Q., Mghames, L., 2021. Lebanon: 389 tons of toxic chemicals removed through ground-breaking work. World Bank Blogs.
[28] IPEN, 2019. Lebanon PFAS Situation Report.

POPs Baseline		PCBs	PFOS	HBCD	SCCP
Montenegro	Production	None / Approx. 2.57 g unintentional annual release (low estimate, not including leakage) <u>NIP(2019)</u> PCBs have never been produced in the territory of Montenegro. The NIP includes an assessment of unintentional release of PCBs in the environment, which is triggered mainly by uncontrolled burning processes at open dumps. The figures between 2006 and 2016 show a gradual decline from 6.79g annual release in 2006 to 2.57g released in 2016. The assessment does not appear to include leakage, which may be a more significant source.	None. <u>NIP(2019)</u> PFOS not produced in Montenegro.	None. <u>NIP(2019)</u> No registered producers of HBCD	No specific data <u>NIP(2019)</u> No information
	Usage	None / negative (due to export for disposal). <u>NIP(2019)</u> The NIP reports that there has been production and overhaul of equipment containing PCBs in the factory "19 decembar" in Podgorica (transformers and capacitors), which resulted in import of fluids containing PCBs. However, the 2019 NIP includes planned measures that aim to fully identify and eliminate fluids in devices by 2025 as well as properly disposing PCB waste. EUR1,950,000 has been allocated through GEF to implement these activities through the *"Comprehensive Environmentally Sound Management of PCBs*[29]*"* Programme. Activities include capacity strengthening to manage PCB-containing waste, conducting a PCB waste inventory, and environmentally sound management of waste containing PCBs. At least 700 tonnes of contaminated equipment and another 200 tonnes of contaminated land is expected to be disposed. According to a 2019 press release, approximately 248 tonnes of PCB contaminated oil, electrical equipment and solid waste was disposed[30].	Between 0.28 and 2.41 tonnes (for the year 2016). <u>NIP(2019)</u> There were no registered production, applications and imports of chemicals containing PFOS and PFOS-related substances in the past 10 years. However, in accordance with inventory guidance the NIP includes a range of estimates for various product types. The estimated imported PFOS quantity for the year 2016 (looking at various product types that can contain PFOS) is in the range of 0.2754 and 2.4122 tonnes. The largest contributors are coating and impregnation of synthetic carpets and textiles.	3.66 tonnes (for the year 2016). <u>NIP(2019)</u> Estimated total consumption of HBCD in Montenegro for the period 2006-2016 is 34,359 tonnes. The latest 2016 figure is 3.661 tonnes. The total estimated amount of HBCD in Montenegro (products that potentially contain it and from construction waste) is 39,187 tonnes.	Limited specific data <u>Rotterdam Convention website</u>[12]: No consent to import / uses of this substance are prohibited under Decree. Montenegro transposed EU's REACH Legislation (Registration, Evaluation, Authorisation and Restriction of Chemicals)

[29] PCB Montenegro, 2018. Environmentally sound management of PCBs.
[30] Polyecogroup, 2019. Completion of PCBs waste management project in Montenegro

		Other uses highlighted in the NIP include fluorescent lamp ballast, as well as use in homes (e.g. heaters, hydraulic systems, and motors as lubricant. Quantities for these have not been reported. Cost-Benefit Analysis (2020) According to a 2020 cost-benefit analysis[31] carried out in relation to above project, currently 82 PCB-containing transformers (of which 31 in use) remain, with a total weight of 285,041 kg, containing 68,811 kg of PCB-containing oil. According to the study, the most favourable option for disposal is the export and final disposal of the PCB-containing transformers – which if indeed implemented will lead to negative net consumption of PCBs in Montenegro. DEKONTA report[32] A study by DEKONTA (risk assessment analysis for KAP Temporary PCB Storage, 2019) reports that PCBs in soil samples at the KAP aluminium plant exceeds both the Dutch intervention limit and recommended UNIDO limits for industrial areas.			

[31] United Nations Development Programme, 2020. Cost-benefit analysis for the disposal of the PCB containing transformers
[32] Dekonta, 2019. Risk Assessment Analysis. Kap Temporary PCB storage.

POPs Baseline	PCBs	PFOS[33]	HBCD	SCCP
Morocco – Production	None / no data on leakage NIP(2019) Morocco ratified the Stockholm Convention in 2004. Today, all transformers produced in Morocco are PCB free. The NIP does not include an assessment of unintentional release of PCBs. UNDP Safe PCB Management Programme[34] PCBs have never been produced in Morocco.	None. NIP(2019) PFOS have never been produced in Morocco. No reporting on PFAS.	None. NIP(2019) HBCD has never been produced in Morocco	No specific data NIP(2019) No information
Morocco – Usage	3,700 tonnes of PCB oil in transformers present / negative consumption due to elimination. NIP(2019) In February 2016, the inventory of transformers contaminated with PCB was as follows: • Total of 103 transformers with contamination above 0.5%, of which 89 still in service. Total of PCB contained in these is 43,785kg. • There are 215 devices (out of service) with contamination below 0.5%, with a total PCB weight of 95,838kg. • At the time of the publication of the report 1,850 transformers have already been eliminated. • 1,530 tonnes of PCB-containing equipment has been eliminated. The deposit of PCB equipment is steadily decreasing. Morocco is the first African country to get a plant for treating PCB contaminated equipment on 17 November 2015 Feasibility Study 3,700 tonnes of PCB oil in transformers that remain in service. 2021article: "Morocco Hosts 1st Decontamination Station for POPs in Africa, Arab World"[35] The Bouskoura station has so far decontaminated 1,740 electrical transformers and 541 tonnes of oils contaminated by POPs.	Approx. between 0.1 and 13 tonnes per year. NIP(2019) Consumption between 1,324.8 and 13,092.0 kg per year. [36] Vast majority attributed to coatings, e.g. paper and packaging, carpets, leather and clothing, textiles and upholstery. Report mentions this is the first inventory of its kind and serves more to provide an impression of sectors and activities, more precise estimate to follow in next report.	Approx. between 127 and 459 tonnes (as of 2013). NIP(2019) Inventory figures, mostly focused on construction and textile sectors. As of 2013, Construction (EPS and XPS polystyrene): between 93.264 and 229.383 tonnes (Transport vehicle) textiles: between 33.647 and 229.408 tonnes Total HBCD as of 2013: between 126,911 and 458,791 kg	No specific data NIP(2019) No information

[33] The Guidance for Developing a National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants (January 2017) requires reporting on PFOS, its salts and PFOSF and PFOS related chemicals. Assessment of PFAS is not included in the guidance, hence reporting is limited. The data provided in this column therefore refers to PFOS unless explicitly stated otherwise.
[34] UNDP Project Document, Safe PCB Management Programme in Morocco Pillar 1
[35] Morocco World News, 2021. Morocco Hosts 1st decontamination station for POPs in Africa, Arab World.
[36] Consumption is defined in Morocco's NIP as "production + import – export"

<table>
<tr><th colspan="2">POPs Baseline</th><th>PCBs</th><th>PFOS</th><th>HBCD</th><th>SCCP</th></tr>
<tr><td rowspan="2">Tunisia</td><td>Production</td><td>None / 8.89kg per year released unintentionally.

NIP (2017)
Tunisia does not produce and has never produced PCBs.

In terms of unintentional release of PCBs, the NIP states that most of the emissions in Tunisia come mainly from the burning of municipal waste in the open air. This source indeed contributes up to 99% of national emissions with quantities of 8.89 kg/year. All other sources are considered negligible (though no assessment of potential leakage).</td><td>None.

NIP (2017)
Tunisia does not produce PFOS / these products are exclusively imported from abroad.</td><td>None.

NIP (2017)
Tunisia does not produce PBDE polybrominated diphenyl ether compounds, including HBCD. These products are therefore exclusively imported from abroad, either in the form of pure products or in the form of manufactured products.</td><td>Limited specific data

NIP(2017)
No information</td></tr>
<tr><td>Usage</td><td>Up to 1,214 tonnes of equipment left / being withdrawn.

NIP (2017)
A 2017 inventory from the national waste management agency identified 2,480 tonnes total of scrapped and in-service equipment (transformers and capacitors). Of which 1,056 tonnes (900 tonnes of equipment and 156 tonnes of contaminated soil) already has been processed.

Feasibility Study
659 tonnes of PCB oil in transformers that remain in services

ANGED[37]
As of 2017, 1,214 tonnes of PCB-contaminated equipment is still in service. Phase 2 of the national PCB management plan (2018-2028) is therefore focused on the gradual withdrawal of equipment still in service until 2025 with the promotion of good techniques and practices for environmentally sound management by 2028.</td><td>PFOS inventory: Approx. 18.4-160.87 tonnes

NIP (2017)
The industrial sector, products and manufactured goods sector, and the chemical products (including fire-fighting foams and hydraulic fluids sector) have been analysed.

Imports of PFOS-containing products have stopped in 2003 and fire-fighting foams since 2011, hence all remaining PFOS remain in waste (both controlled and uncontrolled landfill sites). Estimated quantities for these are between 18.4 tonnes and 160.87 tonnes of PFOS.

The report cautions these are very approximate figures and may not fully reflect reality. This is due to the scattered nature of the stocks and significant proportion of uncontrolled landfills. The NIP recommends that a more specific inventory is undertaken.</td><td>Approx. 85 tonnes annually sold on the market

NIP (2017)
Tunisia does not import HBCD in the form of pure substance. The products are therefore mainly imported in the form of mixtures.

The estimated quantities of HBCD sold annually on the Tunisian market is around 85 tonnes (polystyrene).

The NIP strongly recommends to programme a specific exhaustive inventory of HBCD POPs in Tunisia as particularly content in waste is unknown:

"The inventory of PFOS and PBDE/HBCDD POPs carried out within the framework of this project is carried out for the first time in Tunisia. It cannot claim to fully understand the question relating to the situation of this category of POPs in Tunisia."</td><td>Limited specific data

NIP(2017)
No information</td></tr>
</table>

[37] ANGED [u.d.]. Programme nationale de gestion des polychlorobiphényles PCB.

POPs Baseline		PCBs	PFOS	HBCD	SCCP
Türkiye	Production	None / incomplete data on unintentional releases, 89-2800kg+ annually. NIP (2022) PCBs were never produced in Türkiye, and only imported either within equipment or in the form of oil. The NIP states that the permitted PCB level as per the applicable by-law is 0.1 ng/Nm3. Available data supports the fact that the unintentionally produced PCBs levels are low in the atmosphere. Some studied sites included Izmir, Bursa and Kocaeli, none of which exceeded the permitted level. Some sources of emission were landfill sites. No PCB was detected in water samples. There is no information on the unintentional release of PCBs in the environment or no incidents.	None. NIP (2022) PFOS is not produced in the country but is imported.	None. NIP (2022) There are four producers of expanded, and seven producers of extruded polystyrene in Türkiye. The NIP does not explicitly state HBCD is produced in Türkiye, it is assumed these producers rather use imported HBCD.	No specific data / consent to produce under certain conditions NIP (2022) An SCCP inventory for Türkiye identified SCCP to be present in the country, however no specific data on this chemical have been released, as legislation is new. No indication in the NIP that SCCP is produced in Türkiye. Rotterdam Convention website[21]: According to the By-Law on Persistent Organic Pollutants (Official Gazette no. 30595 dated 14.11.2018), the production, placing on the market (including import) and use of substances or preparations SCCPs in concentrations lower than 1 % by weight or articles containing SCCPs in concentrations lower than 0,15 % by weight are allowed.
	Usage	None / negative (due to export for disposal); 60% of PCB containing materials eliminated by 2016 NIP (2022) The latest 2013 inventory indicates that a total of 1,080 tonnes of pure PCBs containing materials and equipment still remained. Broken down by equipment type as follows: 912 tonnes of transformers (177 items), 138 tonnes of capacitors (2,782 items), and 30 tonnes of contaminated equipment (31 items). There has been a significant amount of reduction in PCBs/PCB containing equipment stocks in the country with the support of international funds. 634 tonnes out of 1,080 tonnes have already been eliminated under the UNEP/MAP MedPartnership Programme. The remaining inventory was scheduled to be eliminated by 2019 during the POPs Legacy Elimination and POPs Release Reduction Project.	Negative / near -12 tonnes consumption in 2019 of PFOS-related substances. NIP (2022) Between 2017 and 2019 the net import amounts significantly decreased. Import quantities decreased between 2017 – 2019, by 985 kg. The latest 2019 consumption figure of is 29 kg/year. The net import amount for PFOS-related substances during the same time period (2017-2019), is positive by 11.43 tonnes. However, there is a strong downward trend, consumption decreased from 18.6 tonnes in 2017 to -11.83 in 2019 There are no detected stockpiles of PFOS, however an analysis of contaminated sites is yet to be completed. The 2022 NIP does not report on PFAS.	None. NIP (2022) Total annual consumption of HBCD was estimated to be 1,214,167 kg. Specifically, HBCD flame retardant use was estimated to be 823.84 tons in 2018. In accordance with the By-law on Persistent Organic Pollutants, the domestic use of HBCD has been banned, and approximately 23 tons of HBCD stock was disposed of.	No specific data / Consent to import under certain conditions NIP (2022) The NIP provides a crude estimate through the TURKSTAT Foreign Trade Information System based on various HS codes (e.g. paints and varnishes, enamels, lacquers, etc.) that are assumed to contain SCCP. The latest 2019 consumption figure is 14.7 tonnes net import of SCCP-containing substances. However, there are no specific data on this chemical, since it is newly introduced in the national legislation, hence there is a high possibility of overestimation in the amounts presented. The NIP calls for a more detailed inventory study for SCCP. Rotterdam Convention website[12]: According to the By-Law on Persistent Organic Pollutants (Official Gazette no.

		According to the 2019 Project implementation report[38], approximately 289 tonnes of PCB-based equipment was eliminated in an environmentally sound manner. The 2022 NIP states that 300 tonnes of PCB containing material and equipment was eliminated, and 6,094 transformers were analysed for PCBs. According to the results of this analysis, 42,6 tonnes of transformer oil having a PCB concentration greater than 50 ppm were decontaminated. The remaining budget for POPs Legacy Elimination project has been transferred to the Ministry of Environment, Urbanisation and Climate Change (MoEUCC) for the implementation of further activities. Therefore, the eliminated amount will likely increase.	Based on TURKSTAT data, there is a decrease in the total net amount of import of PFOS in 2020[39]		30595 dated 14.11.2018), the production, placing on the market (including import) and use of substances or preparations containing SCCPs in concentrations lower than 1 % by weight or articles containing SCCPs in concentrations lower than 0.15 % by weight are allowed.

[38] GEF. POPs legacy elimination and POPs release reduction project.
[39] Turkiye istatistik Kurumu, 2022.

4. Identification of priority sectors

4.1 Introduction

Based on the findings of the country-specific research summarised in the preceding section, priority sectors have been identified for each of the four target POPS in the eight countries of interest, as set out in Table 2 below.

A number of other sectors were considered but were discounted from further detailed consideration on the basis of *inter alia* the size of that sector compared with others or the low use of POPs in that sector for the ENVITECC countries, meaning that they were not classed as a priority use area or sector.

Sectors reviewed, but excluded from further detailed investigation, are summarised below for completeness, with reasons given for their exclusion.

4.2 Sectors excluded from further consideration

4.2.1 PFOS and associated salts

Household cleaning products and detergents

There is no reference to the potential presence of PFOS in household cleaning products and detergents in either the BAT/BEP Guidance[40], or the OECD report[41]. A 2015 paper[42] which analysed the presence of PFAS in a wide range of consumer products notes that PFAS can be contained in industrial detergents but makes no reference to the potential for PFOS contamination.

However, three of the NIPs make reference to PFOS in household cleaning products and detergents as follows:

Albania:	Provides estimate of PFOS potentially present in 'cleaning house products' using PFOS content of 0.005 – 0.01%, which results in a maximum range of 50 – 100 kg annually.
Bosnia and Herzegovina:	No data or estimates given
Montenegro:	Provides estimates of PFOS potentially present in cleaning agents, waxes and polishes for the three years 2014 – 2016 using PFOS content of 0.005 – 0.01%, which results in a maximum range of 13.6 – 36.4 kg annually.

Given that both the Albania and Montenegro NIPs assumed that all imported materials within the category contain PFOS, and that the more recent UNEP/OECD documents make no reference to this sector as a potential source of POPs, the masses predicted are likely to be a significant overestimate. This sector has therefore not been considered further.

[40] UNEP (2021). Guidance on best available techniques and best environmental practices for the use of perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and their related substances listed under the Stockholm Convention on Persistent Organic Pollutants.
[41] OECD, 2015: Risk reduction approaches for PFASs – a cross country analysis
[42] Kotthoff, M et al, 2015. Perfluoroalkyl and polyfluoroalkyl substances in consumer products

Hydraulic fluids

Aviation hydraulic fluids were formerly an acceptable purpose for use of PFOS but were removed under decision SC-9/4, which entered into force on 3 December 2020; there are no specific exemptions registered for this use in the ENVITECC countries.

Aviation hydraulic fluids previously contained a PFOS-related substance, or precursor, at concentrations of typically <0.05%[43] – 0.1%[44] to prevent evaporation, fires and corrosion, although it should be noted that PFOS-free alternatives were available, and widely used before 2020.

Alternative fluorine-free chemicals are now used instead, as are fluorinated chemicals other than PFOS. However, some of the fluorinated chemicals are likely to have POPs-like characteristics in terms of persistence.

Detailed information on the properties of alternatives is restricted by manufacturers because of commercial sensitivities, although the majority of aviation hydraulic fluids contain phosphate esters. Hydraulic fluids used in other applications, which have less restrictive specifications may be phosphate ester free or biodegradable.

Six of the eight NIPs make reference to hydraulic fluids as follows:

Albania:	Provides estimate of PFOS potentially present based on assumed consumption of 10,000 kg and PFOS concentration of 0.05-0.1% which results in an annual range of 5 – 10 kg PFOS.
Bosnia and Herzegovina:	No data or estimates given
Lebanon:	Data received from Middle East Airlines maintenance department showed that only PFOS free hydraulic fluids were used over the period 2004 – 2014.
Montenegro:	Provides estimates of PFOS potentially present in aviation hydraulic fluid based on amounts of hydraulic fluid used each year over the period 2006 – 2015 and using the typical concentrations of PFOS added of 0.05-0.1% which results in a maximum range of 0.12 – 0.62 kg of PFOS annually. However, the hydraulic fluid mentioned in the NIP (Skydrol 500-B4) is PFOS free[45] and therefore the estimates should be treated with extreme caution.
Morocco:	Provides estimate of PFOS potentially present based on total imports of 18,089 kg and PFOS concentration of 0.05-0.1% which results in an annual range of 9.0 – 18.1 kg PFOS.
Türkiye:	Table AIV/24 in the NIP indicates that Türkiye is a significant net exporter of aviation hydraulic fluids. However, no estimate is provided for the

[43] UNEP (2021). BAT / BEP guidance on practices for the use of perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and their related substances listed under the Stockholm Convention on Persistent Organic Pollutants
[44] UNEP (2011) Guidance on alternatives to PFOS and its derivatives (UNEP/POPS/POPRC.6/13/Add.3f)
[45] Eastman, 2014. PFOS in Skydrol® aviation hydraulic fluids

approximate PFOS amounts for the listed categories (e.g. engine oils, compressor and turbine oils, etc.), and some of these may not even contain PFOS.

Historic or current data concerning quantities of hydraulic fluids used at a regional / global level are not available[46] and it is therefore not possible to attempt to estimate the amounts of PFOS that may have been used; any attempt at estimation would be further complicated by the fact that PFOS-free alternatives have been in use for some time and so using the range of 0.05 – 0.1% is likely to lead to an overestimation. A recent paper[47] indicated that the hydraulic fluid in an airbus A320 would be completely replaced in 13 months through maintenance / topping up; this would indicate that any remaining PFOS-containing hydraulic oil would now have been replaced.

The data in the NIPs where an estimate has been made should be treated with caution for the reasons given above and are likely to be overestimates; even so, the quantities predicted in the eight countries are far lower than those arising in other uses and so this sector has not been considered further.

Metal plating

Metal plating defined as "*…(hard metal plating) only in closed-loop systems*" remains as a specific exemption under decision SC-9/4, which entered into force on 3 December 2020. The exemption specifically relates to functional chromium plating, whereby a layer of chromium is directly deposited onto substrates using electrolysis to provide a corrosion resistant surface.

Electrolysis is a wet process and PFOS or other fluorinated wetting agents are used to reduce surface tension of the liquid to reduce drag-out losses from the plating bath and to improve surface quality of the products. Most importantly, the electrolytic process can cause bubbles and mist to be ejected from the plating bath; this mist is released to the work environment and eventually ambient air unless controlled with air pollution control equipment and/or chemical fume (mist) suppressants. The use of PFOS (or other wetting agents) therefore plays a key role in reducing the Cr(VI) concentration in the working air[48].

The most common alternative (6:2 fluorotelomer sulfonate (FTS), which is marketed under several trade names) is much less stable than PFOS, which means that a much greater amount (up to ten times more) is needed, relative to PFOS, to achieve the same protective effect. Moreover, 6:2 FTS degrades to perflourohexanic acid, which is itself a PFAS. All known alternatives contain fluorine.

The BAT/BEP guidance[49] refers to a number of alternative processes for hard metal plating that are available in Europe but notes that none can cover all the applications of functional chromium plating.

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[46] Stockholm Convention [u.d.]. POPRC.8 Documents.
[47] Obergruber, Michal & Hönig, Vladimir & Procházka, P. & Táborský, Jan. (2018). Diagnostics of hydraulic fluids used in aviation. Agronomy Research. 16.
[48] Chromium (VI) is itself extremely toxic and a known carcinogen
[49] UNEP (2021). BAT / BEP guidance on practices for the use of perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and their related substances listed under the Stockholm Convention on Persistent Organic Pollutants

Six of the eight NIPS make reference to metal plating as follows:

Bosnia and Herzegovina:	Reference but no data
Lebanon:	Ten metal plating companies were contacted although only five responded, all of whom were decorative metal platers for which there is no exemption for the use of PFOS; two respondents stated that they were not using PFOS. However, the NIP concludes that it is possible that PFOS is still in use but no estimates are given.
Montenegro:	Reference but no data
Morocco:	Reference but no data
Tunisia:	Reference but no data
Türkiye:	Although metal plating is identified as a priority sector for PFOS, there is no further reference to metal plating and no data are provided.

Paints, adhesives, coatings

The specific exemption allowing the use of PFOS in coatings and coating additives was removed in 2015 under decision SC-7/5. However, production had peaked between 1990 – 2000[50] and their use had been largely phased out before this date following the decision of the main global manufacturer, 3M to phase out PFOS in 2000[51], with production having completely ended two years later[52]. Moreover, a recent OECD report[53] on the commercial availability and current uses of PFAS in coatings, paints and varnishes found no evidence of PFOS in any uses.

Albania:	Provides estimate of PFOS potentially present based on assumed consumption of 10,000 kg and PFOS concentration of 0.05-0.1% which results in an annual range of 5 – 10 kg PFOS.
Bosnia and Herzegovina:	No data or estimates given.
Lebanon:	Paint and varnish factories surveyed (ten out of twelve responses) stated that no chemicals containing PFOS used in their production. MSDS of a further two factories previously audited were reviewed and no PFOS containing materials were detected.
Montenegro:	Provides estimates of PFOS potentially present in surface coating, paints and varnishes based on total amounts imported each year over the

[50] Environment Agency (2019): Perfluorooctane sulfonate (PFOS) and related substances: sources, pathways and environmental data

[51] EPA, 2000. EPA and 3M announce phase out of PFOS.

[52] OECD, 2015: Risk reduction approaches for PFASS – a cross country analysis

[53] OECD, 2022: Per- and Polyfluoroalkyl Substances and Alternatives in Coatings, Paints and Varnishes (CPVs), Report on the Commercial Availability and Current Uses, OECD Series on Risk Management, No. 70, Environment, Health and Safety, Environment Directorate.

period 2014 – 2016 and using a PFOS concentration of 0.01% which results in a maximum range of 3.2 – 5.8 kg of PFOS annually.

Tunisia: No data or estimates given

Türkiye: No data or estimates given

It should be noted that the inventory guidance notes that PFOS were only added in specific limited circumstances[54]; given that both the Albania and Montenegro NIPs assumed that all imported materials contain PFOS, the masses predicted are likely to be a significant overestimate.

Even so, the quantities predicted are far lower than those arising in other uses and so this sector has not been considered further.

Photo-imaging

Photo-imaging was formerly an acceptable purpose for use of PFOS but was removed under decision SC-9/4, which entered into force on 3 December 2020.

Whilst the amounts of PFOS materials used in the photo-imaging industry have decreased, there remains a small number of critical uses where direct alternatives do not exist[55] or there is insufficient, or contradictory, information available in relation to suitable alternatives[56], several of which are considered to be potential POPs. Indeed, the SC website still notes that 'for some applications like photo imaging …technically feasible alternatives to PFOS are not available to date'[57].

The quantities of PFOS potentially arising from this industry are low when compared with other uses. Work undertaken by UK DEFRA[58], estimates releases into wastewater and air from the photo-imaging industry to be 1.02 kg and 0.051 kg respectively from manufacturing uses in the EU, which has been extrapolated to less than 2 kg globally.

Based on the reductions in the use of PFOS in photo-imaging between 2000-2004, UNEP[59] estimated the costs of further reductions as US$25M/ kg assuming an annual estimated global release of 2kg. It is also worth noting that with the increased take up, and now prevalence, of the use of digital imaging technologies since these calculations were undertaken, there will have been an associated reduction in demand for film and therefore a significant reduction in the amount of PFOS being used.

Five out of the eight NIPs (Albania, Bosnia and Herzegovina, Montenegro, Morocco, and Tunisia) refer to the use of PFOS in the photo-imaging industry. However, an estimate of the

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[54] UNEP, 2017. Guidance for the inventory of perfluorooctane sulfonic acid (PFOS) and related chemicals listed under the Stockholm Convention on Persistent Organic Pollutants UNEP/POPS/COP.7/INF/26

[55] For example, PFOS materials have a combination of surface-active properties that are not found in any other single class of chemicals. Michiels E., 2010. The use of PFOA in critical photographic applications (cited in UNEP, 2021).

[56] UNEP, 2021. BAT / BEP guidance on practices for the use of perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and their related substances listed under the Stockholm Convention on Persistent Organic Pollutants

[57] SC website - alternatives to POPs - PFOS and its salts

[58] AEA, 2012. A further update of the UK source inventories for emissions to air, land and water of dioxins, dioxin-like PCBs, PCBs and HCB, incorporating multi-media emission inventories for nine new POPs under the Stockholm Convention. Report Ref ED47664-

[59] UNEP, 2007. Report of the Persistent Organic Pollutants Review Committee on the work of its third meeting: Addendum - Risk management evaluation on perfluorooctane sulfonate UNEP/POPS/POPRC.3/20/Add.5

amount of PFOS resulting from these uses is only given in the Albanian and Moroccan NIPs as follows:

Albania: Provides estimate of PFOS potentially present based on annual consumption of 50,000 kg and PFOS concentration of 0.02-0.1% which results in an annual range of 10 – 50 kg PFOS.

Morocco: Provides estimate of PFOS potentially present based on net annual consumption of 93,138 kg and PFOS concentration of 0.01% which results in an annual quantity of 9.3 kg PFOS.

It should be noted that the estimates given in the Albanian and Moroccan NIPs represent a significant percentage of the estimated global total in 2010; given that consumption will have decreased considerably over the last decade, the estimates should be treated with caution.

However, given the relatively small quantities of PFOS used in this industry globally, and the further decrease in use resulting from the switch to digital technologies, and the fact that quantities predicted are far lower than those arising in other uses for the two ENVITECC countries where an estimate has been made, this sector has not been considered further.

4.2.2 HBCD

The inventory guidance on HBCD[60] notes that over 90% of HBCD globally is in EPS and XPS in the construction sector, with a small amount of use in textiles and electronics. In the EU, the uses in electronics and in textiles are each estimated at 2%. The focus of the BAT/BEP guidance[61] on HBCD is solely on the EPS and XPS sectors.

However, there is reference to the minor uses in some of the NIPs, which are included below for completeness although they are not considered further.

Electronics

Of the six NIPs which include HBCD, only two include reference to the potential for HBCD in the electronics sector as follows:

Albania: Identifies that HBCD is used in electrical and electronic devices with a concentration of 1-7% (baseline / reference for this concentration is not given). Given that the concentration of HBCD in electrical and electronic equipment is low, no data or estimates have been made.

Morocco: Identifies that HBCD is used, to a minor extent, as a flame-retardant additive in polystyrene shockproof electronic equipment. However, in accordance with the Inventory Guidelines, it is not considered relevant to establish an inventory as the presence of HBCD in this type of product is considered insignificant.

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[60] UNEP, 2021. Guidance on preparing inventories of hexabromocyclododecane (HBCD).
[61] UNEP, 2021: Guidance on best available techniques and best environmental practices for the use of hexabromocyclododecane listed with specific exemptions under the Stockholm Convention

Food packaging

Of the six NIPs which include HBCD, only one includes any reference to the potential for HBCD in food packaging as follows:

Tunisia:	Gives total annual quantities of HBCD used of circa 85 tonnes and states that this is principally used in polystyrene for construction and food packaging but no breakdown given of the amount in each sector.

Paints

Of the six NIPs which include HBCD, three include reference to the potential for HBCD in paints as follows:

Albania:	Single reference to fact that whilst paints may contain HBCD, the concentration is low and so no data or estimates have been made.
Lebanon:	Single reference noting that paints were not considered because it represents a minor potential use of HBCD.
Morocco:	Reference given to the use of HBCD in latex paints (and coatings, glues and binders), but that the use of HBCD in these products is minor overall and it is not established that HBCD is contained in these products in Morocco

Table 2: Priority use areas and sectors for the target POPs in Each ENVITECC country

Priority Use Area	PCBs	PFOS	HBCD	SCCP
Albania				
(1) Exposure to POPs at homes and offices (through uses such as carpets, paints, fire extinguishers, office furniture, construction materials – cable insulation, sealants, adhesives etc.)	N/A	Cardboard, paper and packaging Carpets Textiles Leather	Textiles in household furniture Textiles in vehicle upholstery Insulation foams (EPS/XPS) used in construction Mattresses	Not reported
(2) POPs release to the environment due to industrial/commercial scale production and use of POPs containing fire-fighting foams (at petrochemical sites, refineries, airports, etc.)	N/A	Fire-fighting foams	Not reported	Not reported
(3) Intentional industrial uses of POPs in the manufacturing industry (textile, paper, chemicals etc.)	N/A	Cardboard, paper and packaging Carpets Textiles Leather	Textiles in household furniture Textiles in vehicle upholstery Insulation foams (EPS/XPS) used in construction Mattresses	Not reported
(4) Unintentional release of POPs to the environment from industrial processes	Energy (Electricity / Transformers)	N/A	N/A	Not reported
(5) Other area of use or sector, if any (please identify)	N/A	N/A	N/A	Not reported
Bosnia and Herzegovina				
(1) Exposure to POPs at homes and offices (through uses such as carpets, paints, fire extinguishers, office furniture, construction materials – cable insulation, sealants, adhesives etc.)	N/A	Coatings and coating additives Carpets Cleaning agents Textiles	Not reported	Not reported
(2) POPs release to the environment due to industrial/ commercial scale production and use of POPs containing fire-fighting foams (at petrochemical sites, refineries, airports, etc.)	N/A	Fire-fighting foams	Not reported	Not reported

Priority Use Area	PCBs	PFOS	HBCD	SCCP
(3) Intentional industrial uses of POPs in the manufacturing industry (textile, paper, chemicals etc.)	N/A	N/A	Not reported	Not reported
(4) Unintentional release of POPs to the environment from industrial processes	Energy (Electricity / Transformers) Mining NB: During the military siege a large amount of power generation equipment was damaged - significant hotspots where PCBs may have leaked.	N/A	Not reported	Not reported
(5) Other area of use or sector, if any (please identify)	N/A	N/A	N/A	N/A
Egypt				
(1) Exposure to POPs at homes and offices (through uses such as carpets, paints, fire extinguishers, office furniture, construction materials – cable insulation, sealants, adhesives etc.)	N/A	Not reported	Not reported	Not reported
(2) POPs release to the environment due to industrial/ commercial scale production and use of POPs containing fire-fighting foams (at petrochemical sites, refineries, airports, etc.)	N/A	Not reported	Not reported	Not reported
(3) Intentional industrial uses of POPs in the manufacturing industry (textile, paper, chemicals etc.)	N/A	Not reported	Not reported	Not reported
(4) Unintentional release of POPs to the environment from industrial processes	Energy (Electricity / Transformers)	Not reported	Not reported	Not reported
(5) Other area of use or sector, if any (please identify)	N/A	Not reported	Not reported	Not reported
Lebanon				
(1) Exposure to POPs at homes and offices (through uses such as carpets, paints, fire extinguishers, office furniture, construction	N/A	NIP reports no significant PFOS use in any industry sectors based on interviews.	Insulation foams (EPS/XPS) used in construction Textiles	Not reported

Priority Use Area	PCBs	PFOS	HBCD	SCCP
materials – cable insulation, sealants, adhesives etc.)				
(2) POPs release to the environment due to industrial/ commercial scale production and use of POPs containing fire-fighting foams (at petrochemical sites, refineries, airports, etc.)	N/A	Fire-fighting foams	N/A	Not reported
(3) Intentional industrial uses of POPs in the manufacturing industry (textile, paper, chemicals etc.)	N/A	N/A	Insulation foams (EPS/XPS) used in construction Textiles	Not reported
(4) Unintentional release of POPs to the environment from industrial processes	Energy (Electricity / Transformers) NB: Several power plants and substations sustained serious damage or were totally destroyed and are therefore potentially contaminated.	N/A	N/A	Not reported
(5) Other area of use or sector, if any (please identify)	N/A	N/A	N/A	Not reported
Montenegro				
(1) Exposure to POPs at homes and offices (through uses such as carpets, paints, fire extinguishers, office furniture, construction materials – cable insulation, sealants, adhesives etc.)	N/A	Carpets Textiles Paper and packaging Cleaning agents	Insulation foams (EPS/XPS) used in construction	Not reported
(2) POPs release to the environment due to industrial/ commercial scale production and use of POPs containing fire-fighting foams (at petrochemical sites, refineries, airports, etc.)	N/A	Fire-fighting foams	N/A	Not reported
(3) Intentional industrial uses of POPs in the manufacturing industry (textile, paper, chemicals etc.)	N/A	N/A	Textile Paints Furniture Building materials	Not reported
(4) Unintentional release of POPs to the environment from industrial processes	Energy (Electricity / Transformers)	N/A	N/A	Not reported

Priority Use Area	PCBs	PFOS	HBCD	SCCP
(5) Other area of use or sector, if any (please identify)	N/A	N/A	N/A	Not reported
Morocco				
(1) Exposure to POPs at homes and offices (through uses such as carpets, paints, fire extinguishers, office furniture, construction materials – cable insulation, sealants, adhesives etc.)	N/A Existing PCBs reported in NIP are only present in electric transformers. Hence exposure at homes and offices minimal.	Paper and packaging Carpets Synthetics Leather and clothing Textiles and upholstery Net consumption between 1,276.80 and 12,768.30 kg per year.	Insulation foams used in construction (EPS and XPS) net consumption between 93,264 and 229,383 kg (HBBCD rarely used in interior textiles as well as clothing textiles in Morocco)	Not reported
(2) POPs release to the environment due to industrial/ commercial scale production and use of POPs containing fire-fighting foams (at petrochemical sites, refineries, airports, etc.)	N/A	Not reported	Not reported	Not reported
(3) Intentional industrial uses of POPs in the manufacturing industry (textile, paper, chemicals etc.)	N/A	Aviation Hydraulic Fluids: Net consumption between 9 and 18 kg per year Photography: Net consumption 9.3kg per year	Usage in manufacturing of buses, cars, and trucks: Net consumption between 242 and 1,650 kg	Not reported
(4) Unintentional release of POPs to the environment from industrial processes	Energy (Electricity / Transformers)	Not reported	Not reported	Not reported
(5) Other area of use or sector, if any (please identify)	Not reported	Not reported	Not reported	Not reported
Tunisia				
(1) Exposure to POPs at homes and offices (through uses such as carpets, paints, fire extinguishers, office furniture, construction materials – cable insulation, sealants, adhesives etc.)	N/A	Not reported	Insulation foams (EPS/XPS) used in construction Food packaging	Not reported
(2) POPs release to the environment due to industrial/ commercial scale production and use of POPs containing fire-fighting foams (at	N/A	Fire-fighting foams Hydraulic brake liquids	Not reported	Not reported

Priority Use Area	PCBs	PFOS	HBCD	SCCP
petrochemical sites, refineries, airports, etc.)				
(3) Intentional industrial uses of POPs in the manufacturing industry (textile, paper, chemicals etc.)	N/A	Not reported	Not reported	Not reported
(4) Unintentional release of POPs to the environment from industrial processes	Energy (Electricity / Transformers)	Not reported	Not reported	Not reported
(5) Other area of use or sector, if any (please identify)	N/A	Not reported	Not reported	Not reported
Türkiye				
(1) Exposure to POPs at homes and offices (through uses such as carpets, paints, fire extinguishers, office furniture, construction materials – cable insulation, sealants, adhesives etc.)	N/A (Historic use of lubricants, plasticisers, inks, adhesives, flame-retardants – phased out)	Metal plating Textiles Apparel (clothing) Carpets Paper and cardboard	Insulation foams (EPS/XPS) used in construction Insulation panels/boards Rigid packaging materials Vehicle upholstery Electrical and electronic equipment	Not reported
(2) POPs release to the environment due to industrial/ commercial scale production and use of POPs containing fire-fighting foams (at petrochemical sites, refineries, airports, etc.)	N/A	Not reported	Insulator blocks in trucks/vans	Not reported
(3) Intentional industrial uses of POPs in the manufacturing industry (textile, paper, chemicals etc.)	N/A	Metal Plating Hydraulic Fluids	Upholstered furniture Automotive internal textiles Automobile cushions Packaging materials	Not reported
(4) Unintentional release of POPs to the environment from industrial processes	Energy (Electricity / Transformers) Landfill	Not reported	Not reported	Not reported
(5) Other area of use or sector, if any (please identify)	N/A	Not reported	Not reported	Not reported

5. Technology guide development

5.1 Introduction

This section details off-the-shelf technologies used in the avoidance, treatment, and disposal of POPs. For the priority sectors identified for each target POPs, the availability of technologies has been considered under the headings of Avoidance, Treatment / Remediation and Safe Disposal and categorised as follows:

Technologies commercially available, with no regrettable consequences. (green)

Technologies currently not commercially available, or available technologies are associated with regrettable consequences e.g. are potential POPs or have POPs like characteristics. (amber)

Technologies not available, or limited data (red)

Where alternatives to POPs are provided, further detail regarding environmental impacts, application constraints and financial costs are given in Table 3 of this report.

It should be noted that the inclusion of a particular technology provider does not constitute a recommendation for that company or their technology, rather the purpose is to illustrate the options that exist for a POPs-free alternative for the specific use or context under consideration.

5.2 PCBs

PCBs were banned in 2001, and their use is now therefore highly restricted. Furthermore, the parties to the Convention are required to eliminate the use of PCBs in existing equipment by 2025 and ensure their environmentally sound waste management by 2028. Technologies are therefore only available for the Energy Sector, where PCBs may still be present, principally in oils in transformers and capacitors, although there is little variation in use across the eight countries.

Priority sector:	Avoidance	Treatment/ Remediation	Safe Disposal
Energy	(green)	(red)	(green)

5.3 PFOS

PFOS, its salts and PFOSF were listed in Annex B to the Stockholm Convention in 2009 (decision SC-4/17). Previously, their main use was in carpet manufacturing (90% by weight of total PFOS in the EU) followed by fire-fighting foam and the leather industry[62]. However, with the removal of the specific exemptions and acceptable uses under subsequent SC decisions, the principal exposure to PFOS is from existing stocks of textiles and materials (including carpets) where PFOS has been used as a coating and fire-fighting foams.

The EU restriction on the inclusion of PFOS is 1 microgram per square metre ($1\mu g/m^2$) on textiles and other coated products[63]. Technologies for the treatment and safe disposal of PFAS containing products are available but limited, and costs are likely to be the greatest applicability constraints.

Priority sector:	Avoidance	Treatment/ Remediation	Safe Disposal
Coatings (textile, paper, carpet)			
Fire-fighting foams			

5.4 HBCD

HBCD is most commonly used as insulation, in extended polystyrene (EPS) and extruded polystyrene (XPS)[64], and as flame retardants in textiles.

Alternatives for insulation and textile uses are often POPs or have POPs like qualities. Many are also not commercially available.

Priority sector:	Avoidance	Treatment/ Remediation	Safe Disposal
Insulation			
Textiles			

5.5 SCCPs

Data are extremely limited, as only the Türkiye NIP has been updated since SCCPs were added to the Stockholm Convention in 2017. National experts were not able to provide further information.

Priority sector:	Avoidance	Treatment/ Remediation	Safe Disposal
Flame retardants			
Sealants and adhesives			
Paints and coatings			
Polyvinyl chloride processing			
Metalworking fluids			

[62] Expert Team to Support Waste Implementation (ESWI) 2011: Study on waste related issues of newly listed POPs and candidate POPs.
[63] COMMISSION REGULATION (EU) No 757/2010, Annex I of the Regulation (EC) No 850/2004 on POPs.
[64] Both EPS and XPS are closed-cell foams used for insulation purposes. They consist of the same base materials however are manufactured differently, such that XPS is considerably denser that EPS.

Table 3a: Technology guide – PCBs

Target POPs: PCBs	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
Priority Use Area #1 – Exposure to POPs at homes and offices					
No exposure to PCBs in homes and offices, as PCBs were banned in 2001.					
Priority Use Area #2 – POPs release to the environment due to industrial/commercial scale production **Priority Use Area #3 – Intentional industrial uses of POPs in the manufacturing industry** **Priority Use Area #4 – Unintentional release of POPs to the environment from industrial processes**					
Energy (through leakage) (PCB in oils of transformers, capacitors, circuit breakers)	Avoidance (through replacement with available alternatives)	(1) Replacement with alternative oils: a. Univolt transformer oil b. ENI ITE 600 c. Nynas NYTRO (2) Facilitating access to potentially leaky equipment, use of high integrity equipment (according to BAT/BEP)	Oxidation stability, corrosive sulphur production, seal compatibility, safety, viscosity	Financial, local availability	(1) Univolt transformer oil (2) ENI ITE 600 (3) Nynas NYTRO
	Treatment/remediation	No data	No data	No data	No data
	Safe Disposal	Available technologies drawn from Basel Convention technical guidelines[65]: (1) Alkali metal reduction (2) Base catalysed decomposition (3) Catalytic hydrochlorination[66] (4) Plasma arc[13]	(1) High energy requirements: typically the process operates at atmospheric pressure (sometimes up to 4 atmospheres) and temperatures between 100°C and 180°C.[68] (2) De-chlorination efficiency	(1) No data (2) No data (3) No data (4) PLASCON technology is currently not operating in target countries. There are 4 PCB plants operating in Japan. Pre-treatment is required as the process requires	(1) No data (2) Comparatively inexpensive (3) No data (4) PLASCON (5) Operational costs of furnace at temperatures between 850-1800°C are between ~€0.3 - 1.5 /litre. High temperature incineration (6000°C) costs ~€11 /litre. For fluorine free foams,

[65] UNEP, 2019. General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (UNEP/CHW.14/7/Add.1/Rev.1)
[66] Murena, F., Schioppa, E., Gioia, F. 2000. Catalytic Hydrochlorination of a PCB Dielectric Oil. Environmental Science and Technology.
[68] John Vijgen, International HCH and Pesticides Association and Dr.Ir. Ron McDowall, Auckland New Zealand for Secretariat of the Basel Convention.

Target POPs: PCBs	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
		(5) Plasma melting decomposition[67] (6) Hazardous waste incineration (including cement kiln co-incineration) (7) Supercritical and subcritical water oxidation	(3) Temperature/ duration variable (4) Waste capacity (each PLASCON unit can treat between 1 and 3 t/d of POP waste, depending on its strength and characteristics), destruction efficiency (5) Temperatures up to 1200°C required for effective decomposition (6) Energy intensive as well as high temperatures required (7) Energy intensive and operates at high temperature and pressure. Destruction efficiency > 99.999% recorded for PCBs[69].	liquid or gaseous streams. (5) High energy requirement (6) High energy requirements, heating up to 1400°C (7) Dilution required to decrease organic content to <20%. Potential for formation of other POPs during PCB treatment[70].	incineration costs are estimated to be ~€1 /litre3. However, see below. (6) Hazardous waste incineration facility in Turkey (IZAYDAS) which accepts PCB-contaminated wastes, although it should be noted that the capacity of the facility is relatively small at approximately 40,000 tonnes / year annual throughput[71] and there are also a number of facilities across the EU, which may be available. (7) No available facilities – one small SCWO research plant in France[72] Note that export of POPs contaminated wastes for disposal is governed by the requirements of the Basel Convention[73] on the control of the transboundary movements of hazardous wastes and their disposal.
Unintentional release of PCBs: Principally from waste incineration, including co-incineration of municipal, hazardous, medical	Formation of PCBs is due to : the presence of organic and chlorinated materials (including plastics) in the waste	(1) Pre-treatment / sorting of wastes prior to combustion (2) Control of combustion conditions (3) Air pollution control (4) Emissions monitoring	(1) Remove wastes with high chlorine content and those containing catalysts such as copper, iron, chromium or aluminium. (2) Minimum furnace residence time and temperature (>850'C for 2	(1) Pre-treatment on site may require additional space or equipment if added to an existing facility (2) None; incineration is a well characterised process with a long	(1) Municipal waste incinerators are likely to have emissions control / monitoring equipment already installed. (2) Hazardous waste incineration facility in Turkey (IZAYDAS) which accepts PCB-contaminated wastes, although it should be noted that the capacity of the facility is relatively small at approximately

[67] Murata, M., Osada, M., Takahashi, M.. Tagashira, S., 2005. Plasma Melting and Decomposing Technology for Treating PCB-contaminated Wastes. Nippon Steel Technical Report.
[69] Ministry of Environment of Japan, 2004, cited in UNEP/CHW.14/7/Add.1/Rev.1
[70] UNEP, 2019. General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (UNEP/CHW.14/7/Add.1/Rev.1)
[71] IZAYDAS 2021 annual report. (Available online: www.izaydas.com.tr/files/IZAYDAS-Annual-Report-2021.PDF)
[72] https://www.eras.com/en/supercritical-water-oxidation
[73] Overview of the Basel Convention

Target POPs: PCBs	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
wastes, sewage sludge and animal carcasses[74]	poor control of the combustion process leading to incomplete combustion.	(5) Avoidance of co-incineration	seconds) and excess air to be maintained for each batch of waste(s) processed (3) Installation of air pollution control (APC) equipment) to minimise emissions. (4) Installation of continuous emissions monitoring (CEM) systems on larger plant to enable shut down if limits exceeded. (5) Combustion of single waste streams (specifically for animal carcasses)	operating history and global availability of plant suppliers and operators (3) None; APC is well characterised with different options representing BAT, dependent on waste streams and combustion process (4) Continuous emissions monitoring (CEM) equipment and technologies are well established (5) None	40,000 tonnes / year annual throughput and there are also a number of facilities across the EU, which may be available. Note that export of POPs contaminated wastes for disposal is governed by the requirements of the Basel Convention[75] on the control of the transboundary movements of hazardous wastes and their disposal.

[74] UNEP, 2019. Guidelines on best available techniques and guidance on best environmental practices (2019/2021 updates)
[75] Overview of the Basel Convention

Table 3b: Technology guide – PFOS and associated salts

Target POPs: PFOS (and associated salts)	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
Priority Use Area #1 – Exposure to POPs at homes and offices **Priority Use Area #3 – Intentional industrial uses of POPs in the manufacturing industry**					
Coatings: Textiles (garments and synthetic carpets) and leather	Avoidance (through replacement with available alternatives)	(1) Replacement with fluorine free substances (paraffin, silicone, dendrimer, polyurethane) (2) Clear identification and awareness of POPs free products through certification schemes	(1) Breathability, water repellency, oil repellency, alcohol repellency. stain release, abrasion resistance, self-cleaning, handle, price, environmental impact (2) Independent auditing, reputation, reliability	(1) Alternatives may also have regrettable impacts/ may be POPs (2) Cost of certification	(1) BaseF (Joncryl HPB 1702). Costs 'very competitive'[76] (2) Blue Angel (this is a Germany-based scheme but operates in accordance with the Stockholm Convention). (3) Alternatives for Carpet uses: Maflon® Hexafor ICT Therapel and Thetaguard Daikin Unidyne™ SmartStrand Forever Clean (4) Alternatives for Leather uses: Chemours Capstone™ Maflon Hexafor Rudolf Group Ruco-Coat® ICT Thetaguard and Thetapel Daikin Unidyne
	Treatment / Remediation (of POPs containing material components and/or textile/leather industry wastewater effluents containing POPs)	(1) Chemical: pyrolysis [77,78] (2) Physical: membrane separation [79] (nanofiltration (NF), reverse osmosis (RO), adsorption-based membranes) (3) Thermal degradation (incineration)	(1) viability assessment required: high energy requirements (high pressure and operating temperatures above 430℃) (2) Properties of the active separation layer of the membrane. (3) PFASs could be decomposed under heat	(1) Requires dedicated pyrolysis unit, though this is smaller than some alternatives. Clear emissions regulations yet to be developed. (2) Potentially high costs of installation, operation, maintenance and/or treatment of concentrate.	(1) PYREG GmbH, Dörth, Germany (2) Arbiogaz Istanbul, Turkey (Wastewater treatment). Other providers are available across Europe however there is little data on those in other ENVITECC target countries. (3) No data

[76] Danish Ministry of the Environment, 2015. Alternatives to perfluoroalkyl and polyfluoroalkyl substances (PFAS) in textiles.
[77] Trinh, M. and Chang, M. 2021. Catalytic pyrolysis: New approach for destruction of POPs in MWIs fly ash, Chemical Engineering Journal (405)
[78] Thoma ED, Wright RS, George I, Krause M, Presezzi D, Villa V, Preston W, Deshmukh P, Kauppi P, Zemek PG. Pyrolysis processing of PFAS-impacted biosolids, a pilot study. J Air Waste Manag Assoc. 2022
[79] Jin, T., Peydayesh, M., Mezzanga, R.. 2021. Membrane-based technologies for per- and poly-fluoroalkyl substances (PFASs) removal from water: Removal mechanisms, applications, challenges and perspectives. Environmental International 157.

			treatment, releasing fluorocarbon gases if these gases do not react with other materials such as calcification	(3) High energy requirements, incineration capacity	
	Safe Disposal	(1) Incentivise recovery, recycling and re-use of textile and leather	(1) Condition of textile, cost-effectiveness, content of hazardous materials.	(1) Several barriers to correct recycling of carpets: • Blended yarns are usually shredded, rather than reused to create fresh yarn • For some materials there is no commercial capacity for recycling • Use of adhesives in addition to soiling can lead to contamination such that they cannot be recycled Specialised recycling and wastewater treatment facilities required: • Not currently recycled in Albania • There are no data on environmentally sound management of PFOS wastes in BiH. • Egypt: no data available • Current practice in Lebanon is open dumping or landfilling. There are no identified facilities for the recycling of synthetic carpets in Lebanon. • Morocco: No data • Tunisia developing specific guide for management of PFOS-containing waste. • Türkiye: Action Plan 6.3 in place. to address Sustainable Development Goal 6: Clean Water and Sanitation.	(1) No data found. Costs will vary by country/region.

Coatings: Cardboard, paper and packaging	Avoidance (through replacement with available alternatives)	(1) Replacement with PFAS-free alternatives	(1) Grease protection, waterproofing	(1) Availability of the PFAS-free products in the market	(1) Soak Proof Shield™—Georgia-Pacific manufactures a line of paper plates and bowls under the Dixie® brand coated with Soak Proof Shield™, an acrylic-based coating that does not contain silicone. Enshield®— West Rock produces oil and grease resistant paperboard coated with Enshield® for a variety of food service applications including take-out, bakery, and frozen foods.
	Treatment / Remediation	(1) Chemical: pyrolysis of packaging material where suitable[80,81] (2) Physical treatment for industrial wastewater: membrane separation [82] (nanofiltration (NF), reverse osmosis (RO), adsorption-based membranes)	(1) Viability assessment required: high energy requirements (high pressure and operating temperatures above 430℃) (2) Properties of the active separation layer of the membrane. RO-treated effluent can be further treated to produce drinking water.	(1) Availability, high operational costs (2) Availability of the technology in the local market, potential high operational costs due to membrane cleaning/replacement	(1) No data found (2) Arbiogaz Turkey (Wastewater treatment). Other providers are available across Europe however there are little data on those in other ENVITEC target countries.

[80] Trinh,M. and Chang, M. 2021. Catalytic pyrolysis: New approach for destruction of POPs in MWIs fly ash, Chemical Engineering Journal (405)
[81] Thoma ED, Wright RS, George I, Krause M, Presezzi D, Villa V, Preston W, Deshmukh P, Kauppi P, Zemek PG. Pyrolysis processing of PFAS-impacted biosolids, a pilot study. J Air Waste Manag Assoc. 2022
[82] Jin, T., Peydayesh, M., Mezzanga, R.. 2021. Membrane-based technologies for per- and poly-fluoroalkyl substances (PFASs) removal from water: Removal mechanisms, applications, challenges and perspectives. Environmental International 157.

	Safe Disposal	Potentially available technologies drawn from Basel Convention technical guidelines[83]: (1) Hazardous waste incineration (including cement kiln co-incineration) (2) Gas phase chemical reduction (3) Supercritical and subcritical water oxidation (SCWO)	(1) Energy intensive as well as high temperatures required (2) No data for PFOS (3) No data for PFOS although SCWO is energy intensive and operates at high temperature and pressure	(1) No data for PFOS (2) No data for PFOS (3) No data for PFOS specifically but solid wastes need to have diameter less than 200 microns	(1) Hazardous waste incineration facility in Turkey (IZAYDAS), and there are also a number of facilities across the EU, which may be available. (2) No facilities in Europe / MENA region (3) No available facilities – one small SCWO research plant in France[84] Note that export of POPs contaminated wastes for disposal is governed by the requirements of the Basel Convention on the control of the transboundary movements of hazardous wastes and their disposal.
Paints/ adhesives	Avoidance (through replacement with available alternatives)	(1) Replacement with alternatives: • Hydrocarbon surfactants, eg. Acrylic urethane • Silicone surfactants • Short chain fluorotelomer-based surfactants • Perfluorobutane sulfonate (PFBS)-based compounds • Fluorinated polyethers • Sulfosuuccinates	(1) QUV test (weathering test), CMC value	(1) Compatibility with material of interest.	• Chemguard (used at 0.1wt%) • Chemours Capstone ™ • ICT Flexiwet and Thetawet • Maflon® Hexafor • 3M ™ Paint Primer Concentrate HC-913 • Omnova PolyFox® • AGC Lumiflon ™ • EMD Performance Materials Tivida® • Worlée-Add®
	Treatment /Remediation	No data found	-	-	-
	Safe Disposal	(1) Hazardous waste incineration (2) Supercritical and subcritical water oxidation (SCWO)	(1) Energy intensive as well as high temperatures required (2) No data for PFOS although SCWO is energy intensive and operates at high temperature and pressure	(1) No data for PFOS (2) No data for PFOS	(1) Hazardous waste incineration facility in Turkey (IZAYDAS), and there are also a number of facilities across the EU, which may be available. (2) No available facilities – one small SCWO research plant in France[85] Note that export of POPs contaminated wastes for disposal is governed by the requirements of the Basel Convention on the control of the transboundary

[83] UNEP, 2019. General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (UNEP/CHW.14/7/Add.1/Rev.1)
[84] https://www.eras.com/en/supercritical-water-oxidation
[85] https://www.eras.com/en/supercritical-water-oxidation

					movements of hazardous wastes and their disposal.
Priority Use Area #2 – POPs release to the environment due to industrial/commercial scale production and use of POPs containing fire-fighting foams					
Fire-fighting foams	Avoidance (through replacement with available alternatives)	(1) Replacement with fluorine-free foams (2) Avoid use of POPs-containing foams for training and testing purposes, in accordance with BAT/ BEP[86]. (3) Develop firewater run-off plans (4) Collect and contain firewater runoff	(1) Biodegradability, further research required to determine chemical potential as POPs (2) Performance relative to POPs-containing foam: film formation, surfactant, viscosity, consistency and reliability. (3) N/A (4) N/A	(1) Financial, fire classification (A/B), Availability (2) Financial, representativeness of live conditions (3) Training capacity (4) Equipment efficiency	(1) Purchase of alternative foams across EU estimated to incur costs of ~€27m per year, (EU), part of which would be offset by savings. If current stocks were to be written off and replaced, additional replacement costs of ~€1bn are estimated in addition to disposal costs of up to €320m (EU). Cleaning/ replacement of contaminated equipment may incur costs in the order of €1bn. Treatment cost for runoff could be ~€0.7 per litre (=up to tens of millions per incident) less expensive if fluorine-free foams are used.[87] (2) Alternatives: • BIO-EX Bio-T, BIOPOL, ECOPOL, BIOFOR • Angus Fire (Trainol). • Solberg Versagard • Respondol ATF • MuniF3 Green Plus • Micro-Blaze Out • Jetfoam ICAO-C • GreenFire® • AvioF3 Green • Auxquimia Unipol-FF

[86] UNEP 2021. Guidance on best available techniques and best environmental practices for the use of perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and their related substances listed under the Stockholm Convention on Persistent Organic Pollutants

[87] Wood Environment and Infrastructure Solutions, 2020. The use of PFAS and Fluorine-free alternatives in fire-fighting foams. Final report produced for European Commission DG Environment / European Chemicals Agency (ECHA)

					Based on current data, prices of fluorine-free and fluorine containing AFFFs are comparable.[88] (3) Costs vary with scope and provider (4) Costs vary with scope and provider
	Treatment/remediation	(1) Wastewater/firewater treatment: adsorption onto adsorbent resins/ GAC. (2) Wastewater/ firewater treatment: Reductive photodegradation[89] (3) Oxidation electrochemical technology (4) Wastewater/firewater treatment: adsorption on nano-adsorbents[90]. Most effective for one-time treatment. (5) Soil/water treatment: biodegradation (6) De-Fluoro PFAS Destruction Technology	(1) Incineration capacity required; landfill space required (for adsorbents) (2) Some evidence of fluoride, sulphate and short chain fluorocarbon formation[91] (3) dependent on several variables, including electrode composition and surface area, initial PFAS concentration, desired level of treatment, voltage, and co-contaminants. Fate of fluorine in the process not yet fully assessed so fluorinated and volatile by-products could be possible. (4) Adsorptive removal efficiency, ecotoxicity. Cost-effectiveness. (5) No data found (6) Efficiency and cost-effectiveness	(1) Evidence of poor efficacy[92]. Landfill space limited. Combustion of POPs contaminants associated with negative environmental and health effects. And production of potentially harmful compounds including hydrofluoric and sulfuric acids. Incomplete combustion products include carbon monoxide, carbonyl difluoride, sulphur oxides (SOx) and fluorinated dioxins and furans. However non-combustion chemical technologies have lower efficacy (2) Lack of large-scale research, cost-effectiveness not yet assessed. (3) Initial costs, availability, lifecycle costs of electrodes. (4) More studies needed to determine nano-adsorbent	(1) up to €100m (sum of soil excavation, incineration, groundwater pump and treat, drinking water reverse osmosis) (2) No data found (3) No data found (4) No data found (5) No data found (6) Aecom De-Fluoro– costing available on request.

[88] *Ibid.*
[89] Qu, Y., Zhang, C., Li, F., Chen, J., Zhou, Q., 2010. Photo-reductive defluorination of perfluorooctanoic acid in water. Water Research (44,9)
[90] Ighalo, J., Yao, P., Iwuzor, K., Aniagor, C., Liu, T., Dulta, K., Iwuchuku, F., Rangabhashiyam,S. 2022. Adsorption of persistent organic pollutants (POPs) from the aqueous environment by nano-adsorbents: a review. Environmental Research 212.
[91] Yamamoto, T., Noma, Y., Sakai, S., Shibata, Y. 2007. Photodegradation of perflurooctane sulphonate by UV Irradiation in water and alkaline 2-propanol.

				and secondary pollutant ecotoxicity, and safe disposal of spent absorbents. Environmental factors affecting degradation are temperature, pH, presence of toxic or inhibitory substance acceptors and interactions among microorganisms. (5) No data (6) Financial	
	Safe Disposal	(1) Release control and post treatment may include a combination of types of post-treatments, including the use of cyclones and multi-cyclones, electrostatic filters, static bed filters, scrubbers, selective catalytic reduction, rapid quenching systems and carbon adsorption[93].	(1) Post treatment highly dependent on POPs characteristics and concentrations.	(1) Financial	(1) Costs of disposal by incineration at temperatures between 850-1800°C are between ~€0.3 - 1.5 /litre. High temperature incineration (6000°C) costs ~€11 /litre. For fluorine free foams, incineration costs are estimated to be ~€1 /litre[3].
Priority Use Area #4 – Unintentional release of POPs (uPOPs) to the environment from industrial processes					
<u>All uses</u>	Avoidance (through replacement with available alternatives)	(1) Specific training according to BAT/BEP: • Appropriate education of workers concerning handling, storing, using and disposing of chemicals and auxiliaries, especially in case of hazardous substances • Process- and machinery-specific training to increase the level of environmental awareness • Regular maintenance of technical equipment	(1) N/A (2) N/A	(1) Training capacity (2) Training and management capacity.	(1) Costs of training and replacements are highly variable, however long-term cost saving likely due to the avoidance of contaminated land 'clean-up' operations.[84] (2) As above.

[93] UNEP, 2019. General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (UNEP/CHW.14/7/Add.1/Rev.1)

		(machines in production as well as abatement and recovery devices such as filters and scrubbers); general maintenance (e.g. pumps, valves, level switches); • Calibration of equipment for measuring and dispensing chemicals; and • The drain is never an appropriate disposal system for chemicals. (2) Minimisation of chemical use according to BAT/BEP: • Minimise the use of all chemicals and auxiliary materials; • Measure, mix and dose chemicals carefully to avoid losses; • Minimise residual, left-over chemicals, by calculating exactly how much is needed for the process step; • Substitution of overflow rinsing or minimisation of water consumption in overflow rinsing by means of optimised process control; • Reuse of rinsing baths, including final rinsing baths – where possible; • Reversing of current flows in continuous washing; and • Cleaning and recycling of process water – where possible.			

Table 3c: Technology guide – HBCD

Target POPs: HBCD	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
Priority Use Area #1 – Exposure to POPs at homes and offices Priority Use Area #3 – Intentional industrial uses of POPs in the manufacturing industry					
Insulation[94] (HBCD use as a flame retardant in EPS/XPS boards used in construction)	Avoidance (through replacement with available alternatives)	It should be noted that no 'drop-in' replacement chemicals are commercially available. (1) Alternative materials and product redesign techniques include: • EPS and XPS without flame retardants, using thermal barriers. • Polyisocyanurate foams, including modified urethane foams. • Phenolic foams. • Blankets (fibre batts or rolls) that may contain rock wool, fibre glass, cellulose, or polyurethane foam. • Cellular glass, foam glass Polyester batts. • Loose fills that may contain rock wool, fibre glass, cellulose, or polyurethane foam. • Reflective insulation systems. (2) Use of alternative flame retardants • Saytex BC-48	(1) Alternative chemicals: • Polyisocyanurate foams may emit toxic fumes if burnt, otherwise low toxicity in use, but manufacture involves the use of isocyanates (potent respiratory sensitisers), cannot be recycled. • Phenolic foams have low toxicity in use but manufactured from potentially toxic and carcinogenic materials. No recycling present. • Fibre glass blankets or batts, loose-fill fibre glass, perlite and loose-fill rock wool are innately fire and heat resistant and pose no more than a minor risk to health. The materials can be recycled after use. (2) Also based on polybrominated chemicals, may have associated environmental issues. It	(1) Financial, thermal performance, ecotoxicity.[95] (2) These technologies are not recommended; They are currently significantly more expensive than HBCD, and the toxicological and environmental issues are yet to be evaluated.[96]	(1) The raw material cost of mineral wool is reported to be slightly higher than the EPS raw material cost and lower than the raw material cost of XPS. (2) These substances are currently much more expensive than HBCD.

[94] DEFRA, 2010. Costs and Benefits of the Addition of Hexabromocyclododecane (HBCD) to the Stockholm Convention and the 1998 POPs Protocols.
[95] U.S. Environmental Protection Agency. 2014. Flame retardant alternatives for Hexabromocyclododecane (HBCD).
[96] Saunders, 2017. Characterization of toxicities, environmental concentrations, and bio-accessibilities of novel brominated flame retardants.

Target POPs: HBCD	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
		• Saytex BCL-462 • BE-51	was concluded that these materials should not be considered as readily available for use in the construction sector due to limitations imposed as a result of the REACH regulations for new chemical applications.		
	Treatment/remediation	(1) Sodium persulfate (PS) has been successfully used as a co-milling reagent with milling balls made of zirconia.[97]	(1) Trials are ongoing, thus the process is not yet commercially available	(1) More research needed	(1) Not yet commercially available
	Safe Disposal	(1) Sorting and separation: as HBCD is a constituent of the primary products, the quantities of wastes that would require sorting and separation of HBCD (where this is possible) are much larger than the tonnage of HBCD actually used. Potentially available technologies drawn from Basel Convention technical guidelines[98]: (2) Hazardous waste incineration (including cement kiln co-incineration)	(1) No data (2) Energy intensive as well as high temperatures required (3) No data for HBCD (4) No data for HBCD although SCWO is energy intensive and operates at high temperature and pressure	(1) Separation facilities required; input volumes potentially large (2) Financial, high-energy requirements of technology and low density of HBCD compared with other waste streams may make them less attractive to incineration facilities. (3) No data for HBCD (4) No data for HBCD specifically but solid wastes need to have diameter less than 200 microns	(1) No data (2) Hazardous waste incineration facility in Turkey (IZAYDAS), and there are also a number of facilities across the EU, which may be available (3) No facilities in Europe / MENA region (4) No available facilities - one small SCWO research plant in France Note that export of POPs contaminated wastes for disposal is governed by the requirements of the Basel Convention on the control of the transboundary movements of hazardous wastes and their disposal.

[97] Yan, X., Liu, X., Lin, C., Li, C., Li, P., Wang, H., 2017. Disposal of hexabromocyclododecane (HBCD) by grinding assisted with sodium persulfate.

[98] UNEP, 2019. General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (UNEP/CHW.14/7/Add.1/Rev.1)

Target POPs: HBCD	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
		(3) Gas phase chemical reduction (4) Supercritical and subcritical water oxidation (SCWO)			
Textile[99] (as flame retardant, used in clothing textiles, household furniture, vehicle upholstery etc)	Avoidance (through replacement with available alternatives)	(1) There are currently no appropriate replacements for HBCD within this sector. The use of non-flame retarded products, or inadequately protected products, would not be tenable.	(1) As a polymeric substance, the potential for adverse environmental and health effects may be lower than other brominated chemicals.	(1) N/A	(1) N/A
	Treatment/remediation	(1) Sodium persulfate (PS) has been successfully used as a co-milling reagent with milling balls made of zirconia.[100]	(1) Not yet commercially available	(1) More research needed	(1) Not yet commercially available
	Safe Disposal	(1) There are no readily available methods for sorting and removing the flame-retarded materials from the remainder of the textile products. It is therefore assumed that the entire waste stream would need to be diverted from landfill and sent for disposal by high temperatures incineration as for Priority use area #1 above	(1) As above for Priority use area #1	(2) As above for Priority use area #1	(1) As above for Priority use area #1

[99] DEFRA, 2010. Costs and Benefits of the Addition of Hexabromocyclododecane (HBCD) to the Stockholm Convention and the 1998 POPs Protocols.
[100] Yan, X., Liu, X., Lin, C., Li, C., Li, P., Wang, H., 2017. Disposal of hexabromocyclododecane (HBCD) by grinding assisted with sodium persulfate.

Target POPs: HBCD	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
Priority Use Area #2 – POPs release to the environment due to industrial/commercial scale production and use of POPs containing fire-fighting foams					
Evidence not sufficient to suggest unintentional release of HBCD to the environment from industrial processes.					
Priority Use Area #4 – Unintentional release of POPs to the environment from industrial processes					
Use as flame retardant in expanded and extruded polystyrene foams (EPS and XPS)	Avoidance (through replacement with available alternatives)	(1) Alternatives to HBCD for use as flame retardant in expanded and extruded polystyrene foams (EPS and XPS) are listed above. Furthermore, BAT/BEP recommends the following measures to minimise emissions risk where alternatives are not available[101] • Implementation of an EMS • Establishment, maintenance and regular review of a channelled and diffuse emissions to air inventory as part of the EMS • Use of an integrated waste gas management and treatment strategy that includes process integrated recovery and abatement techniques (2) Limiting the number of emission points. The combined treatment of waste gases with similar characteristics ensures	Preparation and implementation of a leak detection and repair (LDAR) programme.	N/A	N/A

[101] BAT/BEP Group of Experts, 2021. Guidance on best available techniques and best environmental practices for the use of hexabromocyclododecane listed with specific exemptions under the Stockholm Convention

Target POPs: HBCD	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
		more effective and efficient treatment.			

Table 3d: Technology guide – SCCP

Target POPs: SCCPs	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
Priority Use Area #1 – Exposure to POPs at homes and offices					
Flame retardants (rubber and plastics)	Avoidance (through replacement with available alternatives)	(1) Replacement with: • Medium-Chain Chlorinated Paraffins (C14-17) (MCCPs) • Long-Chain Chlorinated Paraffins (C18+) (LCCPs) • Acrylic polymers • Aluminium trihydroxide, used in conjunction with antimony trioxide (ATH) • Antimony trioxide (or Antimony oxide) • Other Organophosphorus flame retardants (in general) • Phosphorus based compounds (in general) • Phthalates (generally, including phthalates esters) • Zinc borate (2) Flame retardancy can be achieved through the use of alternate techniques, such as using inherently flame-resistant materials, flammability barriers and product re-design.	(1) Many of these are POPs or have POP-like characteristics. MCCPs in particular, have been considered to be listed under the Stockholm Convention, although this has been opposed. More data are required to characterise the environmental impacts of suggested alternatives[102]. (2) Performance as flame retardants	No data	No data

[102] Du X, Yuan B, Zhou Y, Benskin JP, Qiu Y, Yin G, Zhao J. 2018. Short-, Medium-, and Long-Chain Chlorinated Paraffins in Wildlife from Paddy Fields in the Yangtze River Delta. Environ Sci Technol.

Target POPs: SCCPs	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
		Alternative conveyor types that do not contain SCCPs, such as PVC solid woven and chloroprene (CR) multi-ply, are available.			
	Treatment/remediation	No data	No data	No data	No data
	Safe Disposal	Potentially available technologies drawn from Basel Convention technical guidelines[103]: (1) Hazardous waste incineration (including cement kiln co-incineration) (2) Gas phase chemical reduction Supercritical and subcritical water oxidation (SCWO)	(1) Energy intensive as well as high temperatures required (2) No data for SCCP No data for SCCP although SCWO is energy intensive and operates at high temperature and pressure	(1) High energy requirements, heating up to 1400°C (2) No data for SCCP No data for SCCP specifically but solid wastes need to have diameter less than 200 microns	(1) Hazardous waste incineration facility in Turkey (IZAYDAS), and there are also a number of facilities across the EU, which may be available. (2) No facilities in Europe / MENA region (3) No available facilities – one small SCWO research plant in France Note that export of POPs contaminated wastes for disposal is governed by the requirements of the Basel Convention on the control of the transboundary movements of hazardous wastes and their disposal.
Sealants and Adhesives	Avoidance (through replacement with available alternatives)	(1) Replacement with alternatives: • Medium-Chain Chlorinated Paraffins (C14-17) (MCCPs) • Long-Chain Chlorinated Paraffins (C18+) (LCCPs); • Phosphate esters • Phthalates (generally, including phthalates esters) • Polyacrylate esters	(1) Many of these are POPs or have POP-like characteristics, see above.	No data	No data

[103] UNEP, 2019. General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (UNEP/CHW.14/7/Add.1/Rev.1)

Target POPs: SCCPs	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
	Treatment/remediation	No data	No data	No data	No data
	Safe Disposal	Potentially available technologies drawn from Basel Convention technical guidelines[104]: (1) Hazardous waste incineration (including cement kiln co-incineration) (2) Gas phase chemical reduction (3) Supercritical and subcritical water oxidation (SCWO)	(1) Energy intensive as well as high temperatures required (2) No data for SCCP (3) No data for SCCP although SCWO is energy intensive and operates at high temperature and pressure	(1) High energy requirements, heating up to 1400°C (2) No data for SCCP (3) No data for SCCP specifically but solid wastes need to have diameter less than 200 microns	(1) Hazardous waste incineration facility in Turkey (IZAYDAS), and there are also a number of facilities across the EU, which may be available. (2) No facilities in Europe / MENA region (3) No available facilities – one small SCWO research plant in France Note that export of POPs contaminated wastes for disposal is governed by the requirements of the Basel Convention on the control of the transboundary movements of hazardous wastes and their disposal.
Paints and Coatings	Avoidance (through replacement with available alternatives)	(1) Replacement with alternatives • Medium-Chain Chlorinated Paraffins (C14-17) (MCCPs) • Long-Chain Chlorinated Paraffins (C18+) (LCCPs) • Boron- and silicon-based compounds (Ex: Phosphorous-boron-nitrogen compounds) • Diisobutyrate compounds • Other Organophosphorus flame retardants • Phosphate esters • Phosphorus based compounds	(1) Many of these are POPs or have POP-like characteristics, see above.	No data	No data

[104] UNEP, 2019. General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (UNEP/CHW.14/7/Add.1/Rev.1)

Target POPs: SCCPs	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
		• Phthalates (generally, including phthalates esters) • Polyacrylate esters			
	Treatment/remediation	No data	No data	No data	No data
	Safe Disposal	Potentially available technologies drawn from Basel Convention technical guidelines[105]: (1) Hazardous waste incineration (including cement kiln co-incineration) (2) Gas phase chemical reduction (3) Supercritical and subcritical water oxidation (SCWO)	(1) Energy intensive as well as high temperatures required (2) No data for SCCP (3) No data for SCCP although SCWO is energy intensive and operates at high temperature and pressure	(1) High energy requirements, heating up to 1400°C (2) No data for SCCP (3) No data for SCCP specifically but solid wastes need to have diameter less than 200 microns	(1) Hazardous waste incineration facility in Turkey (IZAYDAS), and there are also a number of facilities across the EU, which may be available. (2) No facilities in Europe / MENA region (3) No available facilities – one small SCWO research plant in France Note that export of POPs contaminated wastes for disposal is governed by the requirements of the Basel Convention on the control of the transboundary movements of hazardous wastes and their disposal.
Unintentional release throughout product lifetime (including volatile loss, leaching loss, and erosion/particulate losses)	Avoidance (through replacement with available alternatives)	No data	No data	No data	No data
	Treatment/remediation	No data	No data	No data	No data
	Safe disposal	(1) For industrial uses, waste is likely to be treated as hazardous waste, however rubbers, textiles and painted articles may not be disposed of in this way outside industrial usage. When not recycled, treated articles are landfilled	(1) Rate of loss: from 0.05% for volatile loss of rubber products to 5% for erosion of sealants and adhesives.	No data	No data

[105] UNEP, 2019. General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (UNEP/CHW.14/7/Add.1/Rev.1)

Target POPs: SCCPs	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
		(municipal waste) or incinerated.			
Priority Use Area #2 – POPs release to the environment due to industrial/commercial scale production and use of POPs containing fire-fighting foams					
Polyvinyl Chloride Processing	Avoidance (through replacement with available alternatives)	(1) Alternatives for use in polyvinyl chloride (PVC) applications include: • Acrylic polymers • Alumina trihydrate • Aluminium trihydroxide, used in conjunction with antimony trioxide (ATH) • Aluminium trioxide • Antimony trioxide (or Antimony oxide) • Long-Chain Chlorinated Paraffins (C18+) (LCCPs) • Medium-Chain Chlorinated Paraffins (C14-17) (MCCPs) • Other Organophosphorus flame retardants • Phthalates (generally, including phthalates esters) • Tri-octyl trimellitate (TOTM) • Zinc borate	(1) Many of these are POPs or have POP-like characteristics.	No data	No data
	Treatment/remediation	No data	No data	No data	No data
	Safe Disposal	Potentially available technologies drawn from	(1) Energy intensive as well as high temperatures required (2) No data for SCCP	(1) High energy requirements, heating up to 1400°C (2) No data for SCCP	(1) Hazardous waste incineration facility in Turkey (IZAYDAS), and there are also a number of facilities

Target POPs: SCCPs	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
		Basel Convention technical guidelines[106]: (1) Hazardous waste incineration (including cement kiln co-incineration) (2) Gas phase chemical reduction (3) Supercritical and subcritical water oxidation (SCWO)	(3) No data for SCCP although SCWO is energy intensive and operates at high temperature and pressure	(3) No data for SCCP specifically but solid wastes need to have diameter less than 200 microns	across the EU, which may be available. (2) No facilities in Europe / MENA region (3) No available facilities – one small SCWO research plant in France Note that export of POPs contaminated wastes for disposal is governed by the requirements of the Basel Convention on the control of the transboundary movements of hazardous wastes and their disposal.
Priority Use Area #3 – Intentional industrial uses of POPs in the manufacturing industry					
Metalworking Fluids (MWF)	Avoidance (through replacement with available alternatives)	(1) Replacement with environmentally adapted lubricants (EALs) • oil-in-water emulsions, vegetable based • bio-based lubricant formulations (soybean, pine tree, rapeseed, mustard, grape seed, sunflower, coconut, canola, etc), with or without additives • bio-based lubricants in combination with supercritical CO2 (scCO2)	(1) However, they may not be suitable for all applications. Some of these may exhibit POPs characteristics or other hazardous properties. In textile applications many are POPs or exhibit POPs characteristics. (2) No data (3) Biodegradability, toxicity, performance	(1) No data (2) No data (3) Characteristics and associated hazards	(1) Potential to reduce waste treatment costs for MWF effluents (2) No data (3) No data

[106] UNEP, 2019. General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (UNEP/CHW.14/7/Add.1/Rev.1)

Target POPs: SCCPs	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
		• (e.g. oil-in-CO2 dispersion) • gas-based lubricant system (2) Replacement with HIGTO(1) (rapeseed based modified triglyceride) with a zirconium coating. (3) Replacement with other alternatives • Alkanol amides (e.g., 2:1 di-ethanolamine (DEA) tall oil fatty acid alkanol amide) • Isopropyl oleate • Long-chain chlorinated paraffins (C18+) (LCCPs) • Medium-chain chlorinated paraffins (C14-17) (MCCPs) • Nitrated compounds (e.g. Doverlube NCEP-nitrogen containing compound) • Overbased calcium sulphonates • PEP additives • Phosphorus based compounds (4) Use of alternative techniques • Gas based systems such as supercritical CO_2.			
	Treatment/remediation	(1) Effective segregation is required. Spills and contamination to wastewater should be	(1) Segregation methods can be costly and require energy intensive processes[96].	(2) Availability and financial	(3) Costs vary by method; limited data available.

Target POPs: SCCPs	POPs Management Measures	Available technologies and/or practices	Parameters to characterise efficiency and eligibility	Applicability Constraints	Technology Providers and CAPEX/OPEX
		minimized. There are several technologies used for recycling and treatment of metalworking fluids. Gravity and vacuum filtration are used to separate solids. Generally, disposable filters are used. Hydrocyclones and Ultrafiltration are other methods of treatment[107].			
	Safe Disposal	Potentially available technologies drawn from Basel Convention technical guidelines[108]: (1) Hazardous waste incineration (including cement kiln co-incineration) (2) Gas phase chemical reduction (3) Supercritical and subcritical water oxidation (SCWO)	(1) Energy intensive as well as high temperatures required (2) No data for SCCP (3) No data for SCCP although SCWO is energy intensive and operates at high temperature and pressure	(1) High energy requirements, heating up to 1400°C (2) No data for SCCP (3) No data for SCCP specifically	(1) There is a hazardous waste incineration facility in Turkey (IZAYDAS), and there are also a number of facilities across the EU, which may be available. (2) No facilities in Europe / MENA region (3) No available facilities – one small SCWO research plant in France Note that export of POPs contaminated wastes for disposal is governed by the requirements of the Basel Convention on the control of the transboundary movements of hazardous wastes and their disposal.
Priority Use Area #4 – Unintentional release of POPs to the environment from industrial processes					
No data to support unintentional production, not included in SC Article 5 list (release from unintentional POPs) .[109]					

[107] Climate Policy Watcher (2022), Metalworking Fluid Treatment and Recovery.

[108] UNEP, 2019. General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (UNEP/CHW.14/7/Add.1/Rev.1)

[109] The Stockholm Convention lists 5 POPs as applicable to Article 5 (Measure to reduce or eliminate releases from unintentional POPs). Of the POPs included in this study, only PCB is listed. Likewise, the UNEP Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs (2013) makes no mention of SCCP.

Annex 1: Substances listed under the Aarhus Protocol (1998) and the Stockholm Convention (2001) (as amended)

POPs	Stockholm Convention	Aarhus Protocol
Aldrin	✓	✓
Chlordane	✓	✓
Chlordecone	✓	✓
DDT	✓	✓
Decabromodiphenyl ether	✓	
Dicofol	✓	
Dieldrin	✓	✓
Technical Endosulfan and its related isomers	✓	
Endrin	✓	✓
Heptachlor	✓	✓
Hexabromobiphenyl	✓	✓
Hexabromdiphenylether and Heptabromdiphenylether	✓	✓
Hexabromocyclododecane	✓	
Hexachlorobenzene	✓	✓
Hexachlorobutadiene	✓	✓
Alpha hexachlorocyclohexane	✓	
Beta hexachlorocyclohexane	✓	
Lindane	✓	✓
Mirex	✓	✓
Pentachlorobenzene	✓	✓
Pentachlorophenol and its salts and esters	✓	
Pefluorohexane sulfonic acid (PFHxS), its salts and PFHxS-related compounds	✓	
Perfluorooctane sulfonic acid (PFOS), its salts and PFOSF	✓	✓
Perfluorooctanoic acid (PFOA), its salts and PFOA related compounds	✓	
Polychlorinated biphenyls (PCBs)	✓	✓
Polychlorinated dibenzo-p-dioxins (PCDD)	✓	✓
Polychlorinated naphthalenes	✓	✓
Polychlorinated dibenzofurans (PCDF)	✓	✓
Short-chain chlorinated paraffins	✓	✓
Tetrabromodiphenyl ether and pentabromodiphenyl ether	✓	✓
Toxaphene	✓	✓

Annex 2: Target POPs and SC Decisions

Category	SC Annex	Exemptions	Requirements under Annex	Elimination date (if applicable)	Relevant Decisions
Polychlorinated biphenyls **(PCBs)**	A (elimination) C (unintentional POPs)	**Production:** None **Use**: Articles in use in accordance with the provisions of Part II of Annex A, until 2025.	**Elimination:** • Make determined efforts to identify, label and remove from use equipment containing greater than 10 per cent polychlorinated biphenyls and volumes greater than 5 litres. • Make determined efforts to identify, label and remove from use equipment containing greater than 0.05 per cent polychlorinated biphenyls and volumes greater than 5 litres. • Endeavour to identify and remove from use equipment containing greater than 0.005 percent polychlorinated biphenyls and volumes greater than 0.05 litres **Reduction:** • Use only in intact and non-leaking equipment and only in areas where the risk from environmental release can be minimised and quickly remedied. • Not use in equipment in areas associated with the production or processing of food or feed. • When used in populated areas, including schools and hospitals, all reasonable measures to protect from electrical failure which could result in a fire, and regular inspection of equipment for leaks	2025	SC-4/5 SC-4/8 SC-5/7 SC-6/6 SC-7/3 SC-8/3 SC-9/3
Hexabromocyclododecane **(HBCD)**	A (elimination)	**Use**: Expanded polystyrene (EPS) and extruded polystyrene (XPS) in buildings in accordance with the provisions of Part VII of Annex A **Production**: As allowed for the parties listed in the Register in accordance with the provisions of Part VII of Annex A. None of the eight target countries has registered an exception for this group of chemicals.	**Eliminate:** Prohibit and/or take the legal and administrative measures necessary to eliminate: (i) production and use of HBCD (ii) the import and export of HBCD	Banned. Specific exemptions have a limited timeframe and shall expire five (5) years after the date of entry into force of the Convention.	SC-6/13

Category	SC Annex	Exemptions	Requirements under Annex	Elimination date (if applicable)	Relevant Decisions
Short-chain chlorinated paraffins **(SCCPs)**	A (elimination)	**Production:** As allowed for the Parties listed in the Register. **Use**: • Additives in the production of transmission belts in the natural and synthetic rubber industry. • Spare parts of rubber conveyor belts in the mining and forestry industries. Leather industry, in particular fat liquoring in leather. • Lubricant additives, in particular for engines of automobiles, electric generators and wind power facilities, and for drilling in oil and gas exploration, petroleum refinery to produce diesel oil. • Tubes for outdoor decoration bulbs. Waterproofing and fire-retardant paints. • Adhesives. • Metal processing. • Secondary plasticisers in flexible polyvinyl chloride, except in toys and children's products. None of the eight target countries has registered an exception for this group of chemicals.	**Eliminate:** Prohibit and/or take the legal and administrative measures necessary to eliminate: (i) production and use of SCCPs (ii) the import and export of SCCPs	Banned. Specific exemptions have a limited timeframe and shall expire five (5) years after the date of entry into force of the Convention.	SC-8/11
Perfluorooctane sulphonic acid **(PFOS),** its salts and perfluorooctane sulphonyl fluoride.	B (restriction)	**Production:** Acceptable purpose: In accordance with Part III of this Annex, production of other chemicals to be used solely for the use below. Production for uses listed below. Specific exemption**:** None **Use:** Acceptable purpose:	The production and use of perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF) shall be eliminated by all Parties except as provided in Part I of this Annex for Parties that have notified the Secretariat of their intention to produce and/or use them for acceptable purposes.	By the end of 2022, if it has the capacity to do so, restrict uses of Fire-fighting foam that contains or may contain PFOS, its salts and PFOSF to sites where all releases can be contained;	SC-4/17 SC-4/19 SC-5/5 SC-6/4 SC-6/7 SC-7/1 SC-7/5 SC-8/5 SC-9/4

Category	SC Annex	Exemptions	Requirements under Annex	Elimination date (if applicable)	Relevant Decisions
		In accordance with Part III of this Annex for the following acceptable purpose, or as an intermediate in the production of chemicals with the following acceptable purpose: • Insect baits with sulfluramid (CAS No. 4151-50-2) as an active ingredient for control of leaf-cutting ants from Atta spp. and Acromyrmex spp. for agricultural use only. Specific exemption: • Metal plating (hard-metal plating) only in closed-loop systems • Fire-fighting foam for liquid fuel vapour suppression and liquid fuel fires (Class B fires) in installed systems, including both mobile and fixed systems, in accordance with paragraph 10 of part III of this Annex. None of the eight target countries has registered an exception for this group of chemicals.			SC-9/5

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